APPENDIX 2 AIRBORNE SYSTEMS FOR CATEGORY I

1. PURPOSE. This appendix contains airworthiness criteria for the approval of aircraft equipment and installations required to conduct an approach in Category I weather minima.

2. GENERAL. The type certification approval for the equipment, system installations and test methods should be based on a consideration of factors such as the intended function of the installed system, its accuracy, reliability, and fail-safe features, as well as the operational concepts contained in the body of this Advisory Circular (AC). The guidelines and procedures contained herein are considered acceptable methods of determining transport category airplane airworthiness to conduct an approach in Category I weather conditions.

a. The overall assurance of performance and safety of an operation can only be assessed when all elements of the system are considered. This appendix includes a discussion of the non-aircraft elements of a system so that an overall assessment of the operation can be accomplished.

b. References to JAA All Weather Operations Regulations are provided to facilitate the All Weather Operations Harmonization process. A reference to a JAR provision does not necessarily mean that the FAA and JAA requirements are <u>equivalent</u> but they are <u>related with similar intent</u>. The FAA typically may identify which JAR provisions are acceptable to FAA at the time a type certification basis is established.

3. INTRODUCTION. This appendix addresses the approach phase flight. For the purpose of this appendix, the approach phase of flight is defined as the flight segment from the Final Approach Fix (FAF) to the Category I decision altitude/height. This appendix provides criteria which represents an acceptable means of compliance with performance, integrity and availability requirements for low visibility approach. Alternative criteria may be proposed by an applicant. With new emerging technologies, there is a potential for many ways of conducting low visibility approach operations. This appendix does not attempt to provide criteria for each potential combination of airplane and non-airplane elements.

a. Operations using current ILS or MLS ground based facilities and airplane elements are in use, and the certification criteria for approval of these airplane systems are established. Other operations, using non-ground based facilities or evolving ground facilities (e.g., local or wide area augmented Global Navigation Satellite System (GNSS)), and the use of some new aircraft equipment require Proof of Concept testing to establish appropriate criteria for operational approval and system certification. The need for a Proof of Concept program is identified in this advisory circular with a [PoC] designator. This appendix provides some general guidelines, but not comprehensive criteria for airplane systems that require a Proof of Concept.

b. The intended flight path may be established in a number of ways. For systems addressed by this appendix, the reference path may be established by a navigation aid (e.g., ILS, MLS). Other methods may be acceptable if shown feasible by a Proof of Concept **[PoC]**. Methods requiring **PoC** include, but are not limited to:

- the use of ground surveyed waypoints, either stored in an on-board data base or provided by data link to the airplane, with path definition by the airborne system,
- sensing of the runway environment (e.g., surface, lighting and/or markings) with a vision enhancement system.

On-board navigation systems may have various sensor elements by which to determine airplane position. The sensor elements may include ILS, MLS, GNSS, Inertial information, Local Area Differential GNSS, or Pseudolites. Each of these sensor elements should be used within appropriate limitations with regard to accuracy, integrity and availability.

Indications of the airplane position with respect to the intended lateral path can be provided to the pilot in a number of ways.

- deviation displays with reference to navigation source (e.g., ILS receiver, MLS receiver), or

- on-board navigation system computations with corresponding displays of position and reference path, or
- by a vision enhancement system. **[PoC]**

c. The minimum visibility required for safe operations with such systems and backup means will be specified by FAA Flight Standards in the operational authorization.

4. TYPES OF APPROACH OPERATIONS. The airworthiness criteria in this appendix are intended to be consistent with the operational concepts of Section 4.3 of the main body of this AC.

4.1. Operations based on a Standard Landing Aid. ILS and MLS have been characterized by appropriate international (ICAO) standards, and for the purpose of certification in accordance with this Appendix may be considered a Standard Landing Aid (SLA).

Landing Systems based on GNSS (GLS) may use interim United States criteria, or other FAA agreed State criteria, or other international standards developed for acceptable combination of space and ground based elements. Acceptable overall aircraft performance may be established based upon the assumption that these services are used and maintained to the specified standards identified, or as specified in the applicable airworthiness approval.

4.2. Operations based on RNP. The airworthiness criteria in this appendix support the operational concept for RNP as described in Section 4.5 in the main body of this AC.

4.2.1. Standard RNP Types. Approach operations may be specified based upon standard RNP type designations. The type designation identifies the performance standard required to conduct the operation. The RNP Type will have a lateral performance component and may additionally have a vertical component. Refer to Section 4.5.1 in the main body of this AC for Standard RNP Types.

4.2.2. Non-standard RNP Types. Some operations may be approved for Non-Standard RNP Types - Refer to Section 4.5.2 in the main body of this AC. It is envisioned that the airplane systems approval process for Non-Standard RNP Types will be equivalent to that used for Standard RNP Types unless otherwise agreed with the FAA.

4.3. Operations based on Area Navigation System(s). Section 4.3.3, through 4.6 of the main body of this AC provides the criteria for operational authorization of the use of area navigation systems for approach.

a. Instrument approach operations may be approved using aircraft area navigation with lateral and vertical or lateral only capability. The navigation system will typically use multi-sensor capability for position fixing (VOR, DME, GPS, IRS, INS, etc.,) to achieve the necessary performance for certain levels of Category I operations.

b. Required levels of accuracy, integrity and availability for various combinations of sensor dependent operations (e.g., ILS, GLS, VOR, NDB) or area navigation operations (e.g., LNAV/VNAV, LNAV only, or RNP), necessary to support either Category I or Category II instrument approach procedures, as applicable, are specified in sections 5 of the main body of this advisory circular.

5. TYPES OF APPROACH NAVIGATION SERVICE.

5.1. ILS. The ILS is supported by established international standards for ground station operation. These standards should be used in demonstrating airplane system operation.

The Airplane Flight Manual shall indicate that operation is predicated upon the use of an ILS facility with performance and integrity equivalent to, or better than, an ICAO Annex 10 Facility Performance Category I ILS, a U.S. Type I or equivalent.

5.1.1. ILS Flight Path Definition. The required lateral and vertical flight path is inherent in the design of the ILS. Acceptable performance and integrity standards have been established for ILS.

5.1.2. ILS Airplane Position Determination. The airplane lateral and vertical position relative to the desired flight path is accomplished by an airplane ILS receiver which provides deviation from the extended runway centerline path when in the coverage area.

5.2. MLS. The MLS is supported by established ICAO Annex 10 international standards for ground station operation. These standards should be used in demonstrating airplane system operation.

The Airplane Flight Manual shall indicate that operation is predicated upon the use of an MLS facility with performance and integrity equivalent to, or better than, an ICAO Annex 10 Facility Performance Category I MLS, or equivalent.

5.2.1. MLS Flight Path Definition. The lateral and vertical required flight path is inherent in the design of the MLS. Acceptable performance and integrity standards have been established for MLS.

5.2.2. MLS Airplane Position Determination. The airplane lateral and vertical position relative to the desired flight path is accomplished by an airplane MLS receiver which provides deviation from the extended runway centerline path when in the coverage area.

5.3. GLS/GNSS [PoC]. This appendix section is not intended to provide a comprehensive means of compliance for airworthiness approval of GNSS based systems. Currently approved systems are ILS or MLS based. The application of new technologies and systems will require an overall assessment of the integration of the airplane components with other elements (e.g., new ground based aids, satellite systems, advanced radar mapping systems, enhanced vision sensor systems) to ensure that the overall safety of the use of these systems for Category I. This GNSS section is included to identify important differences between conventional ILS/MLS based systems and GNSS based systems that affect GNSS or GLS criteria development.

The performance, integrity and availability of any ground station elements, any data links to the airplane, any satellite elements and any data base considerations, when combined with the performance, integrity and availability of the airplane system, should be at least equivalent to the overall performance, integrity and availability provided by ILS to support Category I operations.

5.3.1. GLS/GNSS Flight Path Definition. Appropriate specification of the required flight path for approach, or approach, landing and rollout (as applicable), is necessary to assure safety of the operation to the relevant operational minima. The required flight path should be established to provide adequate clearance between the airplane and fixed obstacles on the ground, between airplane on adjacent approaches, and to ensure that the airplane stays within the confines of the runway.

a. The effect of the navigation reference point on the airplane flight path and wheel to threshold crossing height must be addressed.

b. The required flight path is not inherent in the design of a GNSS based approach, landing and rollout system, therefore an airplane navigation system must specify a sequence of earth referenced path points, or the airplane must receive information from a ground based system, to define the approach, landing and rollout required path points.

c. Certain path points, waypoints, leg types and other criteria are necessary to safely implement the approach, or approach, landing and rollout operations based on satellite and other integrated multi-sensor navigation systems.

d. Figure 4.6-1 in the main body of this advisory circular shows the minimum set of path points, waypoints and leg types considered necessary to specify the flight path for approach, or approach, landing and rollout operations.

e. The required flight path may be stored in an airplane database for recall and use by the command guidance and/or control system when required to conduct the approach to relevant minima for landing and rollout.

f. The definition, resolution and maintenance of the waypoints which define the required flight path and flight segments is key to the integrity of this type of approach, landing and rollout operation.

g. A mechanism should be established to assure the continued integrity of the flight path designators.

h. The integrity of any data base used to define required path points for an approach should be addressed as part of the certification process. The flightcrew shall not be able to modify information in the data base which relates to the definition of the required flight path for the final approach, and if necessary, initial missed approach.

5.3.2. GLS/GNSS Airplane Position Determination. The safety of an approach operation is, in part, predicated on knowing where the airplane is positioned relative to the required flight path. Navigation satellite systems exist which can provide position information to specified levels of accuracy, integrity and availability. The accuracy, integrity and availability can be enhanced by additional space and ground based elements. These systems provide certain levels of capability to support present low visibility operations and are planned to have additional future capability.

a. Satellite systems have the potential to provide positioning information necessary to guide the airplane during approach. If operational credit is sought for these operations, the performance, integrity and availability must be established to support that operation. Ground based aids such as differential position receivers, pseudolites etc. and a data link to the airplane may be required to achieve the accuracy, integrity or availability for certain types of operation.

b. A level of safety equivalent to current ILS based operations should be established.

c. The role of the satellite based elements in the landing system should be addressed as part of the airplane system certification process until such time as an acceptable national, or international standards, for satellite based systems are established.

Basic GNSS (Un-augmented). This is the basic navigation service provided by a satellite system. No additional elements are used to enhance accuracy or integrity of the operation.

Differential Augmentation. The role of the differential station in the landing system should be addressed as part of the airplane system certification process, unless an acceptable national or international standard, for the ground reference system is established.

Local Area Differential Augmentation. Local Area Differential (LAD) augmentation consists of a set of ground based GNSS receivers that are used to derive pseudo-range corrections and integrity data referenced to a point on or near the airport. This augmentation data is then provided to the airplane via a local, ground based data broadcast signal.

Wide Area Differential Augmentation. Wide Area Differential (WAD) augmentation may be used to provide approach capability supporting appropriate levels of Category I procedures.

5.3.3. Datalink [PoC]. A data link may be used to provide data to the airplane to provide the accuracy necessary to support certain operations (e.g., navigation waypoints, differential corrections for GNSS).

a. The integrity of the data link should be commensurate with the integrity required for the operation.

b. The role of the data link in the approach, or approach and landing system should be addressed as part of the airplane system certification process unless an identified acceptable U.S., or international standard(s) for the data link ground system is applicable and is used.

6. BASIC AIRWORTHINESS REQUIREMENTS. This section identifies airworthiness requirements including those for performance, integrity, and availability which apply to all types of airplane systems, independent of the type of approach and landing or navigation system used. The definitions of Performance, Integrity and Availability are found in Appendix 1. The basic airworthiness criteria are intended to be independent of the specific implementation in the airplane or the type of Approach system being used. Criteria may be expanded further in later sections of this appendix as it applies to a particular airplane system or architecture.

Note: Continuity of Approach Function may involve aircraft systems, ground systems and, in some cases, space based systems. This AC addresses the aircraft part of the system and aircraft criteria will be defined in terms of aircraft system <u>availability</u> to provide quantifiable criteria for airworthiness compliance.

6.1. General Requirements. An applicant shall provide a certification plan which describes how any non-aircraft elements of the Approach System relate to the aircraft system from a performance, integrity and availability perspective. Standard Landing Aids (SLA) can be addressed by reference to ICAO SARPS.

a. The plan for certification shall describe the system concepts and operational philosophy to allow the regulatory authority to determine whether criteria and requirements other than those contained in this appendix are necessary.

b. The Approach system performance should be established considering the environmental and deterministic effects that may reasonably be experienced for the type of operation for which certification and operational approval will be sought.

c. Where reliance is placed on the pilot to detect a failure of engagement of a mode when it is selected (e.g., Go-around); an appropriate indication or warning must be given.

d. The effect of the failures of the navigation facilities must be considered taking into account ICAO and other pertinent State criteria.

e. The effect of the aircraft navigation reference point on the airplane flight path and wheel to threshold crossing height shall be assessed.

6.2. Approach System Accuracy Requirements. The following items are general criteria that apply to the various types of approach operation.

a. Performance shall be demonstrated by flight test, or analysis validated by flight test, using at least 3 different representative facilities for a minimum of 9 total approaches, with a representative range of environmental and system variables which have an effect on overall performance.

b. The performance assessment shall take into account at least the following variables with the variables being applied based upon their expected distribution:

(1) Configurations of the airplane (e.g., flap settings);

(2) Center of gravity;

(3) Landing weight;

(4) Conditions of wind, turbulence and wind shear;

(5) Characteristics of ground and space based systems and aids (ILS, MLS, DGPS, GNSS Satellites); and

(6) any other parameter which may affect system performance (e.g., airport altitude, approach path slope, variations in approach speed).

c. The criteria for acceptable approach performance is based upon acquiring and tracking the required flight path to the appropriate minimum altitude for the procedure. The acquisition should be accomplished in a manner compatible with instrument procedure requirements and flightcrew requirements for the type of approach being conducted.

d. An approach guidance system shall not generate command information (e.g., flight director, HUD etc.) which results in flight path control that is oscillatory or requires unusual effort by the pilot to satisfy the performance requirements.

e. An approach control system shall not generate flight path control (e.g., autopilot) with sustained oscillations.

f. The approach system must cause no sustained nuisance oscillations or undue attitude changes or control activity as a result of configuration or power changes or any other disturbance to be expected in normal operation.

6.2.1. ILS. The performance standards for signal alignment and quality contained in ICAO Annex 10 or an equivalent State standard are acceptable standards for operations based on ILS. These standards shall be used in establishing the performance of the operation.

a. Lateral tracking performance from 1000'HAT to 200' HAT should be stable without large deviations (i.e., within ±50 microamps deviation) from the indicated course.

b. Vertical tracking performance from 700'HAT to 200' HAT should be stable without large deviations (i.e., within ±75 microamps deviation) from the indicated path.

6.2.2. MLS. The performance standards for signal alignment and quality contained in ICAO Annex 10 or an equivalent State standard are acceptable standards for operations based on MLS. These standards shall be used in establishing the performance of the operation.

a. Lateral tracking performance from 1000'HAT to 200' HAT should be stable without large deviations (i.e., within ±50 microamps deviation) from the indicated course or path.

b. Vertical tracking performance from 700'HAT to 200' HAT should be stable without large deviations (i.e., within ±75 microamps deviation) from the indicated path.

6.2.3. GLS [PoC]. Section 5.3 provides background GLS considerations.

a. Lateral tracking performance from 1000'HAT to 200' HAT should be stable without large deviations (i.e., within ±50 microamps deviation) from the indicated course or path, or equivalent.

b. Vertical tracking performance from 700'HAT to 200' HAT should be stable without large deviations (i.e., within ±75 microamps deviation) from the indicated path, or equivalent.

6.2.4. RNP. The accuracy criteria for RNP are designed to enable a seamless transition from en route RNP to approach RNP to be accomplished. RNP operations are based upon the accuracy of the airplane flight path in absolute terms with respect to the defined flight path over the ground. The Total System Error (TSE) will be characterized by the combined performance of airplane systems and any navigation aids. The certification plan should identify any navigation aid(s) on which the RNP performance will be established and how the airplane performance interacts with the navigation aid(s) to meet the TSE performance requirements. The certification plan should identify the assumed relationship between airplane performance and any navigation aid performance.

a. The approach RNP is specified from the FAF to the point along the final approach segment at which the lowest applicable DA (H) typically is applied. There may be one or more levels of RNP specified on a final segment. Missed approach RNP, or levels of RNP if more than one level or RNP is specified, is typically specified from a point related to the lowest applicable DA (H), and typically continues to a missed approach holding fix or missed approach waypoint. RNP also may be applied to a "go-around safety" assessment. When applied to a "go-around safety assessment" the RNP level and associated obstacle clearance start at the end of the touchdown zone with an expanding lateral area that widens to match the level of RNP used, and then continues at the RNP level (s) specified.. The expanding lateral area starts on the centerline for the approach at the end of the touchdown zone and widens at a 7.5 degree splay, or ICAO 1:8 splay, depending on procedure development criteria used. It is applicable from the end of a touchdown zone to reaching the missed approach holding fix or applicable missed approach waypoint (See Appendix 5).

b. Assumptions regarding the performance for any radio navigation aid(s) used should be consistent with ICAO Annex 10 or an equivalent State standard. In cases where site specific geometry must be considered in the evaluation of the NSE, limits on the assumed geometry should be identified

c. The guidance or control system shall be demonstrated to maintain a flight path which tracks the defined flight path to the RNP Type as specified in Section 4.5 of the body of this AC, as applicable.

6.2.5. Flight Path Definition. Refer to Section 4.6. in the main body of this AC for consideration on Flight Path Definition when navigation aids are used which do not have the required flight path inherent in the structure of the signal in space.

6.2.6. Area Navigation Systems. The accuracy requirements for area navigation systems are as specified in AC 25-15, AC 20-129, and AC 20-130, as amended. In addition, criteria described in the table below may alternately be met and referenced in the AFM.

The guidance or control system shall be demonstrated to track the lateral and vertical flight path or lateral flight path alone, if applicable, to one of the levels shown below.

See Section 4.4.4. Main body for vertical performance specification.

The basis for demonstration, or the demonstrated values, should be referenced in the AFM

6.3. Approach System Integrity Requirements. The applicant shall provide the certification authority with an overall operational safety assessment plan for the use of systems other than ILS or MLS for "path in space" guidance. This plan shall identify the assumptions and considerations for the non-aircraft elements of the system and how these assumptions and considerations relate to the airplane system certification plan.

a. The onboard components of the landing system, considered separately and in relation to other associated onboard systems, should be designed to comply with 14 CFR Part 25, section 25.1309, considering any specific safety related criteria identified in this appendix, or as identified in accordance with the operating rules.

b. The following criteria is provided as advisory material for the application of 14 CFR Part 25 section 25.1309 to Landing Systems:

6.3.1. ILS. The aircraft system response to loss of ILS guidance signals (localizer and glideslope) shall be established.

6.3.2. MLS. The aircraft system response to loss of MLS guidance signals (elevation and azimuth) shall be established.

6.3.3. GLS. The aircraft system response to loss of GLS guidance signals shall be established.

6.3.4. RNP. The aircraft system response to loss of the navigation service(s) used to conduct the RNP operation shall be established.

a. The aircraft system response during any switch over to alternate navigation services shall be established.

b. It shall be demonstrated that the airplane will maintain the required flight path within the containment limits (i.e., 2 times the RNP value) when un-annunciated failures not shown to be extremely remote (probability in the order of 10^{-7} per approach, or less) are experienced.

6.3.5. Area Navigation Systems. The integrity requirements for area navigation systems are as specified in AC 25-15, as amended, or equivalent.

6.4. Approach System Availability Requirements. Below 500 ft. on approach, the demonstrated probability of a successful landing should be at least 95% (i.e., no more than 5% of the approaches result in a go-around, due to the combination of failures in the landing system and the incidence of unsatisfactory performance). In addition, a dual or single area navigation (RNAV) approach system installation should meet availability requirements consistent with the operational objective of 14 CFR Part 121, section 121.349, (as applicable to standard Operations Specifications).

6.5. Go-around Requirements. A Go-around may be required following a failure in the Approach System, as required by the flightcrew or by Air Traffic Service at any time prior to touchdown.

a. It should be possible to initiate a missed approach at any point during the approach until touchdown on the runway. It should be safe to initiate a missed approach that results in a momentary touchdown on the runway.

b. A go-around should not require unusual pilot skill, alertness, or strength.

c. The proportion of approaches terminating in a go-around below 500 ft (150 m) due to the combination of failures in the landing system and the incidence of unsatisfactory system performance may not be greater than 5%.

d. Information should be available to the operator to assure that a safe go-around flight path can be determined.

6.6. Flight Deck Information, Annunciation and Alerting Requirements. This section identifies information, annunciations and alerting requirements for the flight deck.

The controls, indicators and warnings must be designed to minimize crew errors that could create a hazard. Mode and system malfunction indications must be presented in a manner compatible with the procedures and assigned tasks of the flightcrew. The indications must be grouped in a logical and consistent manner and be visible under all expected normal lighting conditions.

6.6.1. Flight Deck Information Requirements. This section identifies requirements for basic situational and guidance information.

a. For manual control of approach flight path, the appropriate flight display(s), whether head down or head up, must provide sufficient information, without excessive reference to other cockpit displays, to enable a suitably trained pilot to:

(1) maintain the approach path,

(2) to make the alignment with the runway, and if applicable, safely flare and roll out, or

(3) go-around.

b. Sufficient information should be provided in the flight deck to allow the pilots to monitor the progress and safety of the approach operation, using the information identified above and any additional information necessary to the design of the system.

c. Required in flight performance monitoring capability includes at least the following:

(1) unambiguous identification of the intended path for the approach, and if applicable, safely flare and roll out, (e.g., ILS/MLS approach identifier/frequency, and selected navigation source), and

(2) indication of the position of the aircraft with respect to the intended path (e.g., raw data localizer and glide path, or equivalent).

6.6.2. Annunciation Requirements. A positive, continuous and unambiguous indication must be provided of the modes actually in operation, as well as those that are armed for engagement. In addition, where engagement of a mode is automatic (e.g., localizer and glide path acquisition), clear indication must be given when the mode has been armed by either action of a member of the flightcrew, or automatically by the system (e.g., a pre-land test - LAND 3).

6.6.3. Alerting. Alerting requirements are intended to address the need for warning, caution and advisory information for the flightcrew.

6.6.3.1. Warnings. 14 CFR 25.1309 requires that information must be provided to alert the crew to unsafe system operating conditions and to enable the crew to take appropriate corrective action. A warning indication must be provided if immediate corrective action is required. The design should account for crew alerting cues, corrective action required, and the capability of detecting faults.

6.6.3.2. Cautions. A caution is required whenever immediate crew awareness is required and timely subsequent crew action may be required. A means shall be provided to advise the flightcrew of failed airplane system elements that affect the decision to continue or discontinue the approach.

For RNP systems, the guidance or control system shall indicate to the flightcrew when the Actual Navigation Performance (ANP) exceeds the RNP

6.6.3.3. System Status. Appropriate system status and failure annunciations suited to the guidance systems used, navigation sensors used, and any related aircraft systems (e.g., autopilot, flight director, electrical system) should be provided for the operator to determine prior to departure and the flightcrew to determine after departure, the capability of the airplane approach system components to accomplish the intended approach.

a. While en route, the failure of each airplane component affecting the approach capability should be indicated without flightcrew action. The indication should be an advisory (i.e. not a warning or caution, annunciates without flightcrew action, but does not demand immediate flightcrew attention), unless the failure requires a warning or caution for other reasons (e.g., autopilot disconnect warning).

b. A means shall be provided to advise the flightcrew of failed airplane system elements that affect the decision to continue to the destination or divert to an alternate.

c. System Status indications should be identified by names that are different than operational authorization categories (e.g., do not use names such as "CAT I", "CAT II", "CAT III").

6.7. Multiple Landing Systems and Multi-mode Receivers (MMR). International agreements have established a number of landing systems as an acceptable means to provide guidance to support the conduct of an instrument approach. This section identifies unique requirements which relate to airplane systems which provide the capability to conduct approach and landing operations using these multiple landing systems (e.g., ILS, MLS, GNSS Landing System (GLS)). Typically these multiple landing systems are implemented through use of one or more multi-mode navigation receivers (MMR), capable of providing navigation information for ILS, MLS, and GLS or any one or more combinations of these landing sensor systems.

a. ICAO has specified an ILS protection date of at least 2010 to support international approach and takeoff operations. In addition, MLS or GLS may be used on a regional basis, until GNSS (GLS) based approach, landing and departure system (GLS) are in worldwide use. Accordingly, an operator may elect to use ILS, ILS/MLS, ILS/GLS, or ILS/MLS and GLS. If a Multi-mode Receiver (MMR) is used, MMR characteristics should be consistent with applicable related ARINC characteristics for MMR.

b. For systems which elect to use MLS, either FAA criteria or JAR-AWO as amended, (e.g., NPA AWO 9), may be used as a consideration in defining the airworthiness requirements for MLS certification.

6.7.1. General Requirements. Where practicable, the flight deck approach procedure should be the same irrespective of the navigation source being used.

a. A means (for example the current ILS audio idents) should be provided to confirm that the intended approach aid(s) has been correctly selected.

b. During the approach, an indication of a failure in each non-selected airplane system element must be provided to the flightcrew as an indication of system status; it should not produce a caution or warning;

6.7.2. Indications. The following criteria apply to indications in the flight deck for the use of a multi-mode landing system:

The loss of acceptable deviation data shall be indicated on the display. It is acceptable to have a single failure indication for each axis common to all navigation sources.

6.7.3. Annunciations. The following criteria apply to annunciations in the flight deck when using a multi-mode approach system.

a. The navigation source (e.g., ILS, MLS, GLS, FMS) selected for the approach shall be positively indicated in the primary field of view at each pilot station;

b. The data designating the approach (e.g., ILS frequency, MLS channel, GNSS 'path identifier') shall be unambiguously indicated in a position readily accessible and visible to each pilot;

c. A common set of mode ARM and ACTIVE indications (e.g., LOC and GS) is preferred for ILS, MLS and GNSS operations;

d. A means should be provided for the crew to determine a failure of the non-selected navigation receiver function, in addition to the selected navigation receiver function. When considering equipment failures, the failure indications should not mislead through incorrect association with navigation source. For example, it would not be acceptable for the annunciation "ILS FAIL" to be displayed when the selected navigation source is MLS and the failure actually affects the MLS receiver;

6.7.4. Alerting. Flight operations require alternate airports for takeoff, en route diversion and landing. These alternate airports may have different landing systems. Flight operations may be planned, released and conducted on the basis of using one or more landing systems.

a. The capability of each element of a multi-mode approach and landing system shall be available to the flightcrew to support dispatch of the airplane.

b. A failure of each element of a multi-mode approach and landing system must be indicated to the flightcrew without pilot action, as an advisory (i.e. not a warning or caution, does not demand immediate flightcrew attention), during en route operation.

c. A failure of the active element of a multi-mode approach and landing system during an approach shall be accompanied by a warning, caution, or advisory (i.e. not a warning or caution, annunciates without flightcrew action, but does not demand immediate flightcrew attention), as appropriate.

d. An indication of a failure in each non-selected element of a multi-mode approach and landing system during an approach may be made available to the flightcrew as an advisory (i.e. not a warning or caution, annunciates without flightcrew action, but does not demand immediate flightcrew attention), but should not produce a caution or warning.

6.7.5. Multi-mode Receivers (MMR). For MMRs using more than one or more type(s) of landing system, the means of compliance required for certification can be simplified, provided the applicant provides appropriate justification. This section provides guidance for retrofit certifications, for "ILS Look alike" applications, and for certification of ILS installations with either new or modified receivers.

Typical receiver configurations for retrofit applications include:

(1) An ILS receiver from a new supplier,

(2) A modified ILS receiver from the same supplier (e.g. for purposes of providing improved FM Immunity),

(3) A re-packaged receiver from the same supplier (e.g. the ILS partition in an MMR, or the transition from ARINC 700 to 900 series equipment),

(4) A stand-alone MLS receiver ("ILS look alike"),

(5) An MLS partition in an MMR ("ILS look alike"),

(6) A stand-alone GLS receiver ("ILS look alike"), or

(7) A GLS partition in an MMR ("ILS look alike").

6.7.5.1 "ILS Look alike" Definition applicable to MMR. "ILS Look alike" is defined as the ability of a non-ILS based navigation receiver function to provide operational characteristics and interface functionality to the rest of the aircraft equivalent to that provided by an ILS based receiver function. Specifically in the case of an MLS or GNSS (GLS) based receiver function, the output should be in DDM/microamps, with a sensitivity equivalent to an ILS receiver taking account of the effects of runway length.

6.7.5.2. General Certification Considerations.

6.7.5.2.1. Certification Process. An "impact assessment" should address any new receiver functionality considering:

(1) Differences between the current basis of certification and that requested (if applicable).

(2) The functionality being added.

(3) Credit that can be taken for the existing approval.

6.7.5.2.2. Equipment Approval. TSO/MOPS compliance should be demonstrated where appropriate, including software qualification and receiver environmental qualification to the appropriate levels.

6.7.5.2.3 Aircraft Installation Approval (14 CFR 25). The following should be considered:

(1) Impact on airplane system safety assessments.

(2) Radio approval (e.g. antenna positions, range, polar diagrams, coverage, compatibility between receiver and antenna).

(3) EMI/EMC testing.

4) Functional integration aspects of the receiver with respect to other systems, controls, warnings, displays.

5) Electrical loading

6) Flight data recorder requirements

7) Suitable Aircraft Flight Manual (AFM) provisions.

8) Certification means of compliance for the receiver installation (e.g. specification of ground and/or flight testing, as necessary).

6.7.5.2.4 Alternative Means of Compliance using JAR-AWO. JAR-AWO may be considered as an acceptable means of compliance for ILS or MLS if the applicant establishes that the proposed new or modified navigation receiver configuration can be considered to have "ILS Look alike" characteristics. The following interpretative material to existing ACJ may be considered for that part of the certification affected by the revised installation:

ACJ AWO 131 Performance Demonstration.

2.1 Flight Demonstrations - Program of Landings for Certification.

ACJ AWO 161(b) Failure Conditions.

ACJ AWO 231 Flight Demonstration.

1.1 Continuous Method (Analysis of Maximum Value).

ACJ AWO 431 Performance (Interpretative Material).

6.7.5.2.5 Recertification of an ILS function following the Introduction of a New or Modified ILS Navigation Receiver Installation. The certification program should consider the differences between the new configuration and the pre-existing ILS receiver system. An “impact assessment” may be used to establish a basis for certification.

6.7.5.2.5.1 New or Modified ILS Impact Assessment. An impact assessment should consider the following aspects of the new or modified ILS receiver, or receiver function, for equivalence with the existing ILS receiver configuration:

a) hardware design,

b) software design,

c) signal processing and functional performance,

d) failure analysis,

e) receiver function, installation and integration (e.g. with controls, indicators and warnings).

The impact assessment should also identify any additional considerations such as:

a) Future functionality provisions which have no impact on system operation.

b) Shared resources to support future functionality,

Based upon the assumption that the ILS receiver, or receiver function, can be shown to be equivalent to the current ILS configuration, the applicant may propose that the new installation be treated as a new ILS receiver for installation on a given airplane type.

6.7.5.2.5.2. New or Modified ILS Failure Analysis. The failure characteristics of the new or modified installation should be reviewed, equivalent to systems using ILS data, to ensure that the failure characteristics are compatible with and do not invalidate any original or previous safety assessments.

6.7.5.2.5.3. New or Modified ILS Autoland or HUD Guidance Landing Function Flight Testing (if necessary). For systems intended to provide Autoland or HUD guidance landing function using a new ILS, MLS, GLS or combined MMR receiver, a flight test program of typically a minimum of eight approaches terminating in a successful (automatic or HUD) landing and rollout (if applicable) using the flight control/guidance system, including a minimum of two ILS facilities should be completed. Approaches should include captures from the both sides of the final approach course, at angles and distances representative of typical instrument approach procedures, and if applicable, from below and above the glideslope.

The approach and landing performance (flight path deviation, touchdown data etc.) as appropriate, should be shown to be equivalent to that achieved in the original ILS certification. Recorded flight test data may be required to support equivalency demonstration.

A demonstration of take off guidance performance should be included where applicable.

6.7.5.2.5.4. New or Modified ILS Documentation. The following documentation should be provided for certification:

1. An Impact Assessment including effects on System Safety Assessments

2. A Flight test report, if applicable.

3. Revisions to the Flight Manual where appropriate.

6.7.5.2.6. Recertification following the Introduction of an MLS or GLS Navigation Receiver Installation.

6.7.5.2.6.1. MLS or GLS Introduction Impact Assessment. An MLS or GLS receiver or receiver function, can be certificated with an “impact assessment” similar to that required for the recertification of a new or modified ILS receiver, provided that the unit(s) has(have) been shown to have satisfactory "ILS Look alike" characteristics. The "impact assessment" should assess equivalent aspects of the MLS or GLS receiver or receiver function to those for the existing ILS receiver configuration.

Based upon the assumption that the MLS or GLS receiver or receiver function, can be shown to have "ILS look alike" characteristics, the applicant may propose that the new installation be treated as a new ILS receiver for approval on a particular airplane type.

6.7.5.2.6.3. MLS or GLS Statistical Performance Assessment. If the flight control/guidance system control algorithms are unchanged or effects of any changes are fully accounted for (e.g. navigation reference point), the statistical performance assessment of a currently certificated automatic landing system or Head Up Display landing or takeoff system should typically not have to be re-assessed for the addition of MLS or GLS functionality. This equivalence is based on the assumption that the MLS or GLS receiver, or the MLS or GLS partition of an MMR, can be shown to have satisfactory "ILS Look alike" characteristics.

6.7.5.2.6.4. MLS or GLS Antenna or Navigation Reference Point Location. The implication of differences in position of the MLS or GLS and ILS aircraft antennas or Navigation Reference Point should be assessed considering:

a) Wheel to threshold crossing height,

b) Lateral and vertical antenna position or navigation reference point position effects on flight guidance system performance (including any alignment, flare or rollout maneuvers).

6.7.5.2.6.5. MLS or GLS Introduction Flight testing (as necessary). For an installation of MLS or GLS which can be treated as a new ILS receiver, a flight test program of typically a minimum of 10-15 approaches terminating in a landing and rollout (if applicable) using the flight control/guidance system, including a minimum of two MLS or GLS facilities for each system to be authorized should be completed. The approaches should include captures from the both sides of the final approach course using representative angles and distances, should include captures from below and above the glideslope if applicable, and should include representative wind conditions where antenna or navigation reference point positions may impact performance.

The approach and landing performance (flight path deviation, touchdown data etc.) as appropriate, should be shown to be equivalent to that achieved in the original ILS certification. Recorded flight test data may be required to support equivalency.

A demonstration of take off guidance performance should be included where applicable.

6.7.5.2.6.6 MLS or GLS Introduction Documentation. The following documentation should be provided for certification of MLS or GLS:

1. An Impact Assessment including effects on System Safety Assessments.

2. A Flight test report, if applicable.

3. Revisions to the Flight Manual where appropriate.

6.8 Steep Angle Approaches

The following considerations should be considered before AFM provisions are incorporated for steep angle approaches:

1) The descent gradient range to be demonstrated
2) Suitable "touchdown zone" size considerations, if not standard
3) Adequate descent gradient abuse recovery
4) Adequate speed abuse recovery
5) Engine-failure continuation safety
6) Engine-failure balked or rejected landing safety
7) Adverse tailwind gradients on approach
8) Adverse tailwind component limits at touchdown
9) De-ice and Anti-ice protection considerations
10) Suitability of cockpit visibility during approach and flare
11) Suitability of climb gradient achievable while in the steep angle approach configuration, as necessary
12) Suitability of descent, flare, and touchdown sink rates
13) Provision for drag device (e.g. spoiler or auto-feather) failure
14) Suitability of auto-feather response and time delays, as applicable
15) Flight guidance system compatibility with steep angle approach paths to be flown
16) Antenna function for navigation and communication performance are satisfactory
17) Flight guidance display systems are satisfactory
18) Suitable procedures are provided for approach, rejected landing, and missed approach for all-engine and engine-inoperative cases, and engine failure is addressed at any time until touchdown, during rollout, or after a go around.
19) Any adverse deck angle effects, or landing gear geometry effects are considered

7. APPROACH SYSTEM EVALUATION. An evaluation should be conducted to verify that the pertinent systems as installed in the airplane meet the airworthiness requirements of section 6 of this appendix. The evaluation should include verification of approach system performance requirements and a safety assessment for verification of the integrity and availability requirements. Engine failure cases and other selected failure conditions identified by the safety assessment should be demonstrated by simulator and/or flight tests.

An applicant shall provide a certification plan(s) that describes:

a) The means proposed to show compliance with the requirements of section 6 of this appendix, with particular attention to methods that differ significantly from those described in this appendix.

b) How any non-airplane elements of the Approach System relate to the airplane system from a performance, integrity and availability perspective (e.g., appropriate reference to ICAO Annex or United States Standard).

c) The assumptions on how the performance, integrity and availability requirements of the non-airplane elements of non-Standard Landing Aids will be assured.

d) The system concepts and operational philosophy to allow the regulatory authority to determine whether criteria and requirements in excess of that contained in this appendix are necessary.

Early agreement between the applicant and the FAA should be reached on the proposed certification plan. Upon completion of an FAA engineering design review and supporting simulation studies, a type inspection authorization (TIA) should be issued to determine if the complete installation of the equipment associated with Category I operations meets the criteria of this appendix.

7.1. Performance Evaluation. The performance assessment can be accomplished "in flight", or credited from similar installations as follows:

a. Performance shall be demonstrated by flight test, or analysis validated by flight test, using at least 3 different representative facilities for a minimum of 9 total approaches, with a representative range of environmental and system variables which have an effect on overall performance.

b. Acceptable performance may be established as a by-product of, or in conjunction with, a more restrictive performance demonstration(s) (e.g., Basic type certification, or as a consequence of successfully meeting Category II/III criteria),

1) As a dedicated qualitative "in flight" demonstration of acceptable performance, or

2) By establishing similarity with other mature and acceptably performing system installations. For this provision, "in-flight" demonstration is not necessary, but a functional ground check, bench test, or other equipment check is typically appropriate (e.g., This provision is typically used in the instance of installation of a new model of ILS, VOR, ADF, or DME receiver).

7.2. Safety Assessment. Except as required by any specific safety related criteria identified in this appendix, or by the operating rules, a safety assessment of the Approach system, considered separately and in conjunction with other systems, shall be conducted to show compliance with section 25.1309.

8. AIRBORNE SYSTEM REQUIREMENTS. This section identifies criteria applicable to specific aircraft system architecture selected to conduct the operation. This criteria is developed from operational considerations, approach system considerations, airplane system considerations and the general operational philosophy contained in the body of this AC.

8.1. General. Various airplane systems are expected to comply with the basic performance, integrity and availability requirements are identified in Section 6 of this Appendix.

8.2. Autopilot. Criteria applicable to Autopilot systems is as specified by section 25.1329.

8.3. Head Down Guidance. Criteria applicable to Head Down Guidance systems are specified in the pertinent parts of Section 4 and Section 5 of this appendix.

8.4. Head Up Guidance. The following criteria is applicable to Head Up Guidance systems:

a. The workload associated with use of the HUD should be considered in showing compliance with section 25.1523.

b. The HUD display medium must not significantly obscure the pilot's view through the cockpit window.

c. Control of Approach Flight Path - the HUD must provide sufficient guidance information, without excessive reference to other cockpit displays, to enable a suitably trained pilot to:

(1) maintain the approach path,

(2) go-around.

d. The pilot should be able to align with the runway without the HUD adversely affecting the pilot task. If command information is provided for the flare and landing, it must not be misleading and should be consistent with the characteristics of normal manual maneuvers.

e. If only one HUD is installed, it should be installed at the pilot-in-command crew station.

f. The HUD guidance must not require exceptional piloting skill to achieve the required performance.

g. The HUD system performance and alerting should be consistent with the intended operational use for duties and procedures of the pilot flying (PF) and pilot not flying (PNF) (see sections 5.6 and 5.8 of the main body of this AC).

h. If the autopilot is used to control the flight path of the airplane to intercept and establish the approach path, the point during the approach at which the transition from automatic to manual flight takes place shall be identified and used for the performance demonstration.

i. Any transition from autopilot to HUD guidance must not require exceptional piloting skill, alertness, strength or excessive workload.

8.5. Hybrid HUD/Autoland Systems [PoC]. The following criteria is applicable to Hybrid systems:

a. If a HUD is used to monitor an autoflight system, it should be shown to be compatible with the autoflight system and permit a pilot to detect unsuitable autopilot performance.

b. Other hybrid systems (e.g., including EVS) require a proof of concept **[PoC]** evaluation to establish suitable criteria.

8.6. Satellite Based Approach System. The following criteria is applicable to satellite based approach systems:

a) Satellite based systems should be shown to provide equivalent or better capability than navigation systems based on VOR, DME, or ILS for comparable operations, or meet provisions applicable to RNP.

b) Satellite based systems should not exhibit undue sensitivity to masking of satellite vehicles, or interference from onboard or external sources.

c) Satellite based systems should not exhibit adverse characteristics during acquisition or loss of satellites.

8.7. Area Navigation Systems. Area navigation systems should operate consistent with criteria specified in:

a) AC 25-15, Approval of Flight Management Systems in Transport Category Airplanes,

b) AC 20-129, Airworthiness Approval of Vertical Navigation (VNAV) Systems for use in the U.S. NAS and Alaska, and

c) AC 20-130, Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors, as amended, or equivalent criteria.

In addition, area navigation systems used for approach should have at least the following characteristics:

1) If the operational software (ops program) is modifiable or loadable (e.g., by maintenance action) a "Version" identification must be provided and available for display to the pilot or maintenance personnel (e.g., PS4052520-161, or U7.4, or B767-300.3),

2) A suitable database must be used which can be assured to be suited for the specific aircraft and navigation system type, and which can be assessed to have current data (e.g., Navigation DataBase "NW19810001"),

3) Pilot input/output functions, keys, and displays should have standard functions available, and operate consistent with industry standard conventions and practice,

4) Single systems must be accessible and usable by either pilot located at a pilot or copilot crew station (e.g., the PF or PNF) of a multi-crew aircraft. It is not necessary that such systems also be accessible, or easily accessible, to pilots other than the PF and PNF sitting in a jumpseat (e.g., do not need to be readily accessible to International Relief Officers (IRO's)), but it is recommended that such a system be at least visible to such other pilots (if they have assigned duties) for enhancement of crew coordination and monitoring,

5) Dual (or more) system installations must have a convenient and expedient way to "crossload" and be kept updated. Each system should have CDUs, displays, and annunciations, or equivalent that are at least visible and accessible to both the PF and PNF. This is to provide both for monitoring, and use in failure cases. It is not necessary that such systems also be accessible, or easily accessible, to pilots other than the PF and PNF sitting in a jumpseat (e.g., do not need to be readily accessible to International Relief Officers (IRO's)), but it is recommended that such a system be at least visible to such other pilots (if they have assigned duties) for enhancement of crew coordination and monitoring,

6) System performance must be consistent with operational authorizations sought (see Sections 4 and 5), or should be consistent with an identifiable performance standard such as for various levels of RNP.

7) If credit is sought for operating on complex and closely spaced multiple Waypoint paths, an interface with a suitable "track up" or "heading up" navigation map display is necessary.

8) A means to monitor lateral and vertical deviations should be provided (e.g., displacement display, progress page lateral and vertical deviation).

9) A means must be provided to assure suitable operation or updating, and if RNP is included, to identify the level of RNP to be used, and ANP (or EPE).

8.8 Autothrottle. If autothrottle capability is installed, the applicant should identify any necessary modes, conditions, procedures, or constraints that apply to its use. Use of the autothrottle should not cause unacceptable performance of any autopilot modes intended for use, and any autopilot mode intended for use with autothrottle should not cause unacceptable autothrottle performance. The autothrottle should expeditiously capture any commanded speed adjustments, acceptably maintain speed, and not cause any hazardous conditions with normal use, or for any probable failure modes, considering pilot intervention using normal piloting skills.

8.9. Datalink [PoC]. A data link may be used to provide data to the airplane to provide the accuracy necessary to support the approach.

a. The integrity of the data link should be commensurate with the integrity required for the approach.

b. The role of the data link in the approach system must be addressed as part of the aircraft system certification process until such time as an acceptable national, or international standard, for the ground system is established.

9. Airplane Flight Manual. The Airplane Flight Manual should contain the following information:

1) Any conditions or constraints on Approach performance with regard to Airport conditions (e.g., elevation, ambient temperature, approach path slope, runway slope and ground profile under the approach path).

2) The criteria used for the demonstration of the system, acceptable normal and non-normal procedures, the demonstrated configurations, and types of facilities used, and any constraints or limitations necessary for safe operation.

3) The type of navigation facilities used as a basis for certification. This should not be taken as a limitation on the use of other facilities. The AFM may contain a statement regarding the type of facilities or condition known to be unacceptable for use.

4) Information should be provided to the flightcrew regarding atmospheric conditions under which the system was demonstrated e.g., headwind, crosswind, tailwind etc. The AFM should contain a statement that "Credit may not be predicated on the use of <type of system> if conditions exceed … (those for which the system received airworthiness approval).

5) Any necessary performance, procedure or configuration data to permit an operator to determine climb gradient and transition distances for safe obstacle clearance during a missed approach, balked landing or rejected landing. NOTE: This information need not be specifically included in the AFM if it is available to the operator using some other method acceptable to the operator and manufacturer (e.g. FCOM, supplementary performance information, separate AFM appendix).

Data may be based on corresponding takeoff performance and obstacle assessment data if appropriate accommodation of configuration change and transition distance can be accounted for. Otherwise, additional information on data that may be useful to an operator for determination of engine-inoperative missed performance, maximum allowable weight, or obstacle assessments is discussed in the main body of this advisory circular in Section 4.3.1.8.

Note 1: The AFM limitation section should <u>not</u> specify DA(H) or RVR limitations.

Note 2: AC 25.1581-1 Section 2 discusses AFM contents. The approval status referenced in 2 b (9) (vii) for Category I, II, or III of that AC should be noted in the Normal Procedures Section of the AFM, in accordance with the above provisions. 9. Airplane Flight Manual.

The Airplane Flight Manual should contain the following information:

a. Any conditions or constraints on Approach performance with regard to Airport conditions (e.g., elevation, ambient temperature, approach path slope, runway slope and ground profile under the approach path).

b. The criteria used for the demonstration of the system, acceptable normal and non-normal procedures, the demonstrated configurations, and types of facilities used, and any constraints or limitations necessary for safe operation.

c. The type of navigation facilities used as a basis for certification. This should not be taken as a limitation on the use of other facilities. The AFM may contain a statement regarding the type of facilities or condition known to be unacceptable for use.

d. Information should be provided to the flightcrew regarding atmospheric conditions under which the system was demonstrated e.g., headwind, crosswind, tailwind etc. The AFM should contain a statement that "Credit may not be predicated on the use of <type of system> if conditions exceed … (those for which the system received airworthiness approval).

Note 1: The AFM limitation section should <u>not</u> specify DA(H) or RVR limitations.

Note 2: AC 25.1581-1 Section 2 discusses AFM contents. The approval status referenced in 2 b (9) (vii) for Category I, II, or III of that AC should be noted in the Normal Procedures Section of the AFM, in accordance with the above provisions.

APPENDIX 3 AIRBORNE SYSTEMS FOR CATEGORY II

1. PURPOSE. This appendix contains airworthiness criteria for the approval of aircraft equipment and installations required to conduct an approach in Category II weather minima.

2. GENERAL. The type certification approval for the equipment, system installations and test methods should be based on a consideration of factors such as the intended function of the installed system, its accuracy, reliability, and fail-safe features, as well as the operational concepts contained in the body of this AC. The guidelines and procedures contained herein are considered acceptable methods of determining transport category airplane airworthiness to conduct an approach in Category II weather conditions.

The overall assurance of performance and safety of an operation can only be assessed when all elements of the system are considered. This appendix includes a discussion of the non-aircraft elements of a system so that an overall assessment of the operation can be accomplished.

References to JAA All Weather Operations Regulations (JAR) are provided to facilitate the All Weather Operations Harmonization process. A reference to a JAR provision does not necessarily mean that the FAA and JAA requirements are <u>equivalent</u> but they are <u>related with similar intent</u>. The FAA typically may identify which JAR provisions are acceptable to FAA at the time a type certification basis is established.

3. INTRODUCTION. This appendix addresses the approach phase flight. For the purpose of this appendix, the approach phase of flight is defined as the flight segment from the Final Approach Fix (FAF) to the Category II decision height. This appendix provides criteria which represents an acceptable means of compliance with performance, integrity and availability requirements for low visibility approach. An applicant may propose alternative criteria. With new emerging technologies, there is a potential for many ways of conducting low visibility approach operations. This appendix does not attempt to provide criteria for each potential combination of airplane and non-airplane elements.

Operations using current ILS or MLS ground based facilities and airplane elements are in use, and the certification criteria for approval of these airplane systems are established. Other operations, using non-ground based facilities or evolving ground facilities (e.g., local or wide area augmented GNSS), and the use of some new aircraft equipment require Proof of Concept testing to establish appropriate criteria for operational approval and system certification. The need for a Proof of Concept program is identified in this advisory circular with a **[PoC]** designator. This appendix provides some general guidelines, but not comprehensive criteria for airplane systems that require a Proof of Concept.

Definitive lateral and vertical flight paths are required to conduct an approach in low weather minima conditions. The flight paths should lead to a touchdown in the landing zone and airplane alignment with the axis that passes down the centerline of the runway. Means should be provided on-board the airplane to acquire and track the required flight paths.

The intended flight path may be established in a number of ways. For systems addressed by this appendix, the reference path may be established by a navigation aid (e.g., ILS, MLS). Other methods may be acceptable if shown feasible by a Proof of Concept **[PoC]**. Methods requiring **PoC** include, but are not limited to:

- the use of ground surveyed waypoints, either stored in an on-board data base or provided by data link to the airplane, with path definition by the airborne system, and

- sensing of the runway environment (e.g., surface, lighting and/or markings) with a vision enhancement system.

On-board navigation systems may have various sensor elements by which to determine airplane position. The sensor elements may include ILS, MLS, Global Navigation Satellite System (GNSS), Inertial information, Local Area Differential GNSS, or Pseudolites. Each of these sensor elements should be used within appropriate limitations with regard to accuracy, integrity and availability.

Indications of the airplane position with respect to the intended lateral path can be provided to the pilot in a number of ways.

- deviation displays with reference to navigation source (e.g., ILS receiver, MLS receiver),
- on-board navigation system computations with corresponding displays of position and reference path, **[PoC]** or
- by a vision enhancement system. **[PoC]**

The minimum visibility required for safe operations with such systems and backup means will be specified by FAA Flight Standards in the operational authorization.

4. TYPES OF APPROACH OPERATIONS. The airworthiness criteria in this appendix are intended to be consistent with the operational concepts of Section 4.3 of the main body of this AC.

4.1. Operations based on a Standard Landing Aid. ILS and MLS have been characterized by appropriate international (ICAO) standards, and for the purpose of certification in accordance with this Appendix may be considered a Standard Landing Aid (SLA).

Landing Systems based on GNSS (GLS) may use interim United States criteria, or other FAA agreed State criteria, or other international standards developed for acceptable combination of space and ground based elements. Acceptable overall aircraft performance may be established based upon the assumption that these services are used and maintained to the specified standards identified, or as specified in the applicable airworthiness approval.

4.2. Operations based on RNP. The airworthiness criteria in this appendix support the operational concept for RNP as described in Section 4.5 in the main body of this Advisory Circular.

4.2.1. Standard RNP Types. Approach operations may be specified based upon standard RNP type designations. The type designation identifies the performance standard required to conduct the operation. The RNP Type will have a lateral performance component and may additionally have a vertical component. Refer to Section 4.5.1 in the main body of this AC for Standard RNP Types.

4.2.2. Non-standard RNP Types. Some operations may be approved for Non-Standard RNP Types - Refer to Section 4.5.2 in the main body of this AC. It is envisioned that the airplane systems approval process for Non-Standard RNP Types will be equivalent to that used for Standard RNP Types unless otherwise agreed with the FAA.

4.3. Reserved.

5. TYPES OF APPROACH NAVIGATION SERVICE.

5.1. ILS. The ILS is supported by established international standards for ground station operation. These standards should be used in demonstrating airplane system operation.

The airplane system response during a switchover from an active localizer transmitter to a backup transmitter shall be established.

The Airplane Flight Manual shall indicate that operation is predicated upon the use of an ILS facility with performance and integrity equivalent to, or better than, an ICAO Annex 10 Facility Performance Category II ILS, an U.S. Type II or equivalent.

5.1.1. ILS Flight Path Definition. The required lateral and vertical flight path is inherent in the design of the ILS. Acceptable performance and integrity standards have been established for ILS.

5.1.2. ILS Airplane Position Determination. The airplane lateral and vertical position relative to the desired flight path is accomplished by an airplane ILS receiver that provides deviation from the extended runway centerline path when in the coverage area.

5.2. MLS. The MLS is supported by established ICAO Annex 10 international standards for ground station operation. These standards should be used in demonstrating airplane system operation.

The airplane system response during a switchover from an active azimuth transmitter to a backup transmitter shall be established.

The Airplane Flight Manual shall indicate that operation is predicated upon the use of an MLS facility with performance and integrity equivalent to, or better than, an ICAO Annex 10 Facility Performance Category II MLS, or equivalent.

5.2.1. MLS Flight Path Definition. The lateral required flight path is inherent in the design of the MLS. Acceptable performance and integrity standards have been established for MLS.

5.2.2. MLS Airplane Position Determination. The airplane lateral position relative to the desired flight path is accomplished by an airplane MLS receiver that provides deviation from the extended runway centerline path when in the coverage area.

5.3. GLS/GNSS [PoC]. This appendix section is not intended to provide a comprehensive means of compliance for airworthiness approval of GNSS based systems. Currently approved systems are ILS or MLS based. The application of new technologies and systems will require an overall assessment of the integration of the airplane components with other elements (e.g., new ground based aids, satellite systems, advanced radar mapping systems, enhanced vision sensor systems) to ensure that the overall safety of the use of these systems for Category I. This GNSS section is included to identify important differences between conventional ILS/MLS based systems and GNSS based systems that affect GNSS or GLS criteria development.

The performance, integrity and availability of any ground station elements, any data links to the airplane, any satellite elements and any data base considerations, when combined with the performance, integrity and availability of the airplane system, should be at least equivalent to the overall performance, integrity and availability provided by ILS to support Category I operations.

5.3.1. GLS/GNSS Flight Path Definition. Appropriate specification of the required flight path for approach, or approach, landing and rollout (as applicable), is necessary to assure safety of the operation to the relevant operational minima. The required flight path should be established to provide adequate clearance between the airplane and fixed obstacles on the ground, between airplane on adjacent approaches, and to ensure that the airplane stays within the confines of the runway.

a. The effect of the navigation reference point on the airplane flight path and wheel to threshold crossing height must be addressed.

b. The required flight path is not inherent in the design of a GNSS based approach, landing and rollout system, therefore an airplane navigation system must specify a sequence of earth referenced path points, or the airplane must receive information from a ground based system, to define the approach, landing and rollout required path points.

c. Certain path points, waypoints, leg types and other criteria are necessary to safely implement the approach, or approach, landing and rollout operations based on satellite and other integrated multi-sensor navigation systems.

d. Figure 4.6-1 in the main body of this advisory circular shows the minimum set of path points, waypoints and leg types considered necessary to specify the flight path for approach, or approach, landing and rollout operations.

e. The required flight path may be stored in an airplane database for recall and use by the command guidance and/or control system when required to conduct the approach to relevant minima for landing and rollout.

f. The definition, resolution and maintenance of the waypoints which define the required flight path and flight segments is key to the integrity of this type of approach, landing and rollout operation.

g. A mechanism should be established to assure the continued integrity of the flight path designators.

h. The integrity of any data base used to define required path points for an approach should be addressed as part of the certification process. The flightcrew shall not be able to modify information in the data base which relates to the definition of the required flight path for the final approach, and if necessary, initial missed approach.

5.3.2. GLS/GNSS Airplane Position Determination. The safety of an approach operation is, in part, predicated on knowing where the airplane is positioned relative to the required flight path. Navigation satellite systems exist which can provide position information to specified levels of accuracy, integrity and availability. The accuracy, integrity and availability can be enhanced by additional space and ground based elements. These systems provide certain levels of capability to support present low visibility operations and are planned to have additional future capability.

a. Satellite systems have the potential to provide positioning information necessary to guide the airplane during approach. If operational credit is sought for these operations, the performance, integrity and availability must be established to support that operation. Ground based aids such as differential position receivers, pseudolites etc. and a data link to the airplane may be required to achieve the accuracy, integrity or availability for certain types of operation.

b. A level of safety equivalent to current ILS based operations should be established.

c. The role of the satellite based elements in the landing system should be addressed as part of the airplane system certification process until such time as an acceptable national, or international standards, for satellite based systems are established.

Basic GNSS (Un-augmented). This is the basic navigation service provided by a satellite system. No additional navigation service elements are used to enhance accuracy or integrity of the operation.

0**Differential Augmentation.** The role of the differential station in the landing system should be addressed as part of the airplane system certification process, unless an acceptable national, or international standard, for the ground reference system is established.

Local Area Differential Augmentation. Local Area Differential (LAD) augmentation consists of a set of ground based GNSS receivers that are used to derive pseudo-range corrections and integrity data referenced to a point on or near the airport. This augmentation data is then provided to the airplane via a local, ground based data broadcast signal.

Wide Area Differential Augmentation. Wide Area Differential (WAD) augmentation may be used to provide approach capability supporting appropriate levels of Category I procedures.

Typically only LAD systems provide a basis for establishing the necessary position fixing accuracy, integrity and availability for the final portion of a final approach segment or rollout. Unaugmented GNSS or WAD are typically only suited for support of initial or intermediate segments of an approach, final approach to restricted DA(H)s, or missed approach. GNSS or WAD may however be used in conjunction with Category II procedures for applications such as equivalent DME distance, or marker beacon position determination, when authorized by the operating rules.

5.3.3. Datalink [PoC]. A data link may be used to provide data to the airplane to provide the accuracy necessary to support certain operations (e.g., navigation waypoints, differential corrections for GNSS).

The integrity of the data link should be commensurate with the integrity required for the operation.

The role of the data link in the approach, or approach and landing system should be addressed as part of the airplane system certification process unless an identified acceptable U.S., or international standard(s) for the data link ground system is applicable and is used.

6. BASIC AIRWORTHINESS REQUIREMENTS. This section identifies airworthiness requirements including those for performance, integrity, and availability that apply to all types of airplane systems, independent of the type of approach and landing or navigation system used. The definitions of Performance, Integrity and Availability are found in Appendix 1. The basic airworthiness criteria are intended to be independent of the specific implementation in the airplane or the type of Approach system being used.Criteria may be expanded further in later sections of this appendix as it applies to a particular airplane system or architecture.

> Note: Continuity of Approach Function may involve aircraft systems, ground systems and, in some cases, space based systems. This AC addresses the aircraft part of the system and aircraft criteria will be defined in terms of aircraft system availability to provide quantifiable criteria for airworthiness compliance.

6.1. General Requirements. An applicant shall provide a certification plan which describes how any non-aircraft elements of the Approach System relate to the aircraft system from a performance, integrity and availability perspective. Standard Landing Aids (SLA) can be addressed by reference to ICAO SARPS.

The plan for certification shall describe the system concepts and operational philosophy to allow the regulatory authority to determine whether criteria and requirements other than those contained in this appendix are necessary.

The Approach system performance should be established considering the environmental and deterministic effects that may reasonably be experienced for the type of operation for which certification and operational approval will be sought.

Where reliance is placed on the pilot to detect a failure of engagement of a mode when it is selected (e.g., Go-around), an appropriate indication or warning must be given.

The effect of the failures of the navigation facilities must be considered taking into account ICAO and other pertinent State criteria.

The effect of the aircraft navigation reference point on the airplane flight path and wheel to threshold crossing height shall be assessed.

The use of manual control or the transition from automatic control to manual control must not require exceptional piloting skill, alertness or strength.

6.2. Approach System Accuracy Requirements. The following items are general criteria that apply to the various types of approach operation.

a. Performance shall be demonstrated by flight test, or analysis validated by flight test, using at least 3 different representative facilities for a minimum of 20 total approaches, with a representative range of environmental and system variables which have an effect on overall performance.

b. The performance assessment shall take into account at least the following variables with the variables being applied based upon their expected distribution:

(1) Configurations of the airplane (e.g., flap settings);

(2) Center of gravity;

(3) Landing weight;

(4) Conditions of wind, turbulence and wind shear;

(5) Characteristics of ground and space based systems and aids (ILS, MLS, DGPS, GNSS Satellites); and

(6) any other parameter which may affect system performance (e.g., airport altitude, approach path slope, variations in approach speed).

c. The criteria for acceptable approach performance is based upon acquiring and tracking the required flight path to the appropriate minimum altitude for the procedure. The acquisition should be accomplished in a manner compatible with instrument procedure requirements and flightcrew requirements for the type of approach being conducted.

d. An approach guidance system shall not generate command information (e.g. flight director, HUD etc.) which results in flight path control that is oscillatory or requires unusual effort by the pilot to satisfy the performance requirements.

e. An approach control system shall not generate flight path control (e.g., autopilot) with sustained oscillations.

f. The approach system must cause no sustained nuisance oscillations or undue attitude changes or control activity as a result of configuration or power changes or any other disturbance to be expected in normal operation.

6.2.1. ILS. The performance standards for signal alignment and quality contained in ICAO Annex 10, or an equivalent State standard, are acceptable standards for operations based on ILS. These standards shall be used in establishing the performance of the operation.

a. Lateral tracking performance from 300'HAT to 100' HAT should be stable without large deviations (i.e., within ±25 microamps deviation) from the indicated course, for 95% of the time per approach.

b. Vertical tracking performance from 300'HAT to 100' HAT should be stable without large deviations (i.e., within ±35 microamps deviation) from the indicated path or ±12 ft, whichever is greater, for 95% of the time per approach.

Note: When this provision is applied to path tracking in conjunction with Category III, momentary excursions up to ±75 microamps during test demonstrations may be acceptable if flight guidance system touchdown and landing performance is otherwise shown to be satisfactory.

c. The Continuous Method and the Pass/Fail methods found in JAR ACJ AWO 231 may be used in lieu of the 95% of the time per approach and the minimum number of 20 approaches stated above.

6.2.2. MLS. The performance standards for signal alignment and quality contained in ICAO Annex 10 or an equivalent State standard are acceptable standards for operations based on 1 MLS. These standards shall be used in establishing the performance of the operation.

a. Lateral tracking performance from 300'HAT to 100' HAT should be stable without large deviations (i.e., within ±25 microamps deviation) from the indicated course, for 95% of the time per approach.

b. Vertical tracking performance from 300'HAT to 100' HAT should be stable without large deviations (i.e., within ±35 microamps deviation) from the indicated path or ±12 ft, whichever is greater, for 95% of the time per approach.

Note: When this provision is applied to path tracking in conjunction with Category III, momentary excursions up to ±75 microamps during test demonstrations may be acceptable if flight guidance system touchdown and landing performance is otherwise shown to be satisfactory.

c. The Continuous Method and the Pass/Fail methods found in JAR ACJ AWO 231 may be used in lieu of the 95% of the time per approach and the minimum number of 20 approaches stated above.

6.2.3. GLS [PoC]. Section 5.3 provides background GLS considerations.

a. Lateral tracking performance from 300'HAT to 100' HAT should be stable without large deviations (i.e., within ±25 microamps deviation) from the indicated course or path, or equivalent, for 95% of the time per approach.

b. Vertical tracking performance from 300'HAT to 100' HAT should be stable without large deviations (i.e., within ±35 microamps deviation) from the indicated path or ±12 ft, whichever is greater, or equivalent, for 95% of the time per approach.

Note: When this provision is applied to path tracking in conjunction with Category III, momentary excursions up to ±75 microamps during test demonstrations may be acceptable if flight guidance system touchdown and landing performance is otherwise shown to be satisfactory.

c. The Continuous Method and the Pass/Fail methods found in JAR ACJ AWO 231 may be used in lieu of the 95% of the time per approach and the minimum number of 20 approaches stated above.

6.2.4. RNP. The accuracy criteria for RNP are designed to enable a seamless transition from en route RNP to approach RNP to be accomplished. RNP operations are based upon the accuracy of the airplane flight path in absolute terms with respect to the defined flight path over the ground. The Total System Error (TSE) will be characterized by the combined performance of airplane systems and any navigation aids. The certification plan should identify any navigation aid(s) on which the RNP performance will be established and how the airplane performance interacts with the navigation aid(s) to meet the TSE performance requirements. The certification plan should identify the assumed relationship between airplane performance and any navigation aid performance.

a. The approach RNP is specified from the FAF to the point along the final approach segment at which the lowest applicable DA (H) typically is applied. There may be one or more levels of RNP specified on a final segment. Missed approach RNP, or levels of RNP if more than one level or RNP is specified, is typically specified from a point related to the lowest applicable DA (H), and typically continues to a missed approach holding fix or missed approach waypoint. RNP also may be applied to a "go-around safety" assessment. When applied to a "go-around safety assessment" the RNP level and associated obstacle clearance start at the end of the touchdown zone with an expanding lateral area that widens to match the level of RNP used, and then continues at the RNP level (s) specified.. The expanding lateral area starts on the centerline for the approach at the end of the touchdown zone and widens at a 7.5 degree splay, or ICAO 1:8 splay, depending on procedure devlopment criteria used. It is applicable from the end of a touchdown zone to reaching the missed approach holding fix or applicable missed approach waypoint (See Appendix 5).

b. Assumptions regarding the performance for any radio navigation aid(s) used should be consistent with ICAO Annex 10 or an equivalent State standard. In cases where site specific geometry must be considered in the evaluation of the NSE, limits on the assumed geometry should be identified.

c. The guidance or control system shall be demonstrated to maintain a flight path which tracks the defined flight path to the RNP Type as specified in Section 4.5 of the body of this AC, as applicable.

6.3. Approach System Integrity Requirements. The applicant shall provide the certification authority with an overall operational safety assessment plan for the use of systems other than ILS or MLS for "path in space" guidance. This plan shall identify the assumptions and considerations for the non-aircraft elements of the system and how these assumptions and considerations relate to the airplane system certification plan.

a. The onboard components of the landing system, considered separately and in relation to other associated onboard systems, should be designed to comply with 14 CFR Part 25, section 25.1309, considering any specific safety related criteria identified in this appendix, or as identified in accordance with the operating rules.

b. The following criteria is provided as advisory material for the application of 14 CFR Part 25, section 25.1309 to Landing Systems:

6.3.1. ILS. The aircraft system response to loss of ILS guidance signals (localizer and glideslope) shall be established.

The aircraft system response during a switchover from an active localizer or glideslope transmitter to a backup transmitter shall be established.

6.3.2. MLS. The aircraft system response to loss of MLS guidance signals (elevation and azimuth) shall be established.

The aircraft system response during a switchover from an active elevation or azimuth transmitter to a backup transmitter shall be established.

6.3.3. GLS. The aircraft system response to loss of GLS guidance signals shall be established.

The aircraft system response during any switchover to alternate differential augmentation, pseudolites and datalink services, as applicable, shall be established.

6.3.4. RNP. The aircraft system response to loss of the navigation service(s) used to conduct the RNP operation shall be established.

a. The aircraft system response during any switch over to alternate navigation services shall be established.

b. It shall be demonstrated that the airplane will maintain the required flight path within the containment limits (i.e., 2 times the RNP value) when unannunciated failures not shown to be extremely remote (probability on the order of 10^{-7} per approach, or less) are experienced (i.e., operation with failures).

6.4. Approach System Availability Requirements. Below 500 ft. on approach, the demonstrated probability of a successful landing should be at least 95% (i.e., no more than 5% of the approaches result in a go-around, due to the combination of failures in the landing system and the incidence of unsatisfactory performance). In addition, a dual or single area navigation (RNAV) approach system installation must meet the availability requirements of 14 CFR Part 121, section 121.349, (Operations Specifications).

6.5. Go-around Requirements. A Go-around may be required following a failure in the Approach System, as required by the flightcrew or by Air Traffic Service at any time prior to touchdown.

a. It should be possible to initiate a missed approach at any point during the approach until touchdown on the runway. It should be safe to initiate a missed approach that results in a momentary touchdown on the runway.

b. A go-around should not require unusual pilot skill, alertness, or strength.

c. The proportion of approaches terminating in a go-around below 500 ft (150 m), due to the combination of failures in the landing system and the incidence of unsatisfactory system performance, may not be greater than 5%.

d. Information should be available to the operator to assure that a safe go-around flight path can be determined.

6.6. Flight Deck Information, Annunciation and Alerting Requirements. This section identifies information, annunciations and alerting requirements for the flight deck.

The controls, indicators and warnings must be designed to minimize crew errors that could create a hazard. Mode and system malfunction indications must be presented in a manner compatible with the procedures and assigned tasks of the flightcrew. The indications must be grouped in a logical and consistent manner and be visible under all expected normal lighting conditions.

6.5. Go-around Requirements. A Go-around may be required following a failure in the Approach System, as required by the flightcrew or by Air Traffic Service at any time prior to touchdown.

a. It should be possible to initiate a missed approach at any point during the approach until touchdown on the runway. It should be safe to initiate a missed approach that results in a momentary touchdown on the runway.

b. A go-around should not require unusual pilot skill, alertness, or strength.

c. The proportion of approaches terminating in a go-around below 500 ft (150 m), due to the combination of failures in the landing system and the incidence of unsatisfactory system performance, may not be greater than 5%.

d. Information should be available to the operator to assure that a safe go-around flight path can be determined.

6.6.2. Annunciation Requirements. A positive, continuous and unambiguous indication must be provided of the modes actually in operation, as well as those that are armed for engagement. In addition, where engagement of a mode is automatic (e.g., localizer and glide path acquisition), clear indication must be given when the mode has been armed by either action of a member of the flightcrew, or automatically by the system (e.g., a pre-land test - LAND 3).

6.6.3. Alerting. Alerting requirements are intended to address the need for warning, caution and advisory information for the flightcrew.

6.6.3.1. Warnings. 14 CFR 25.1309 requires that information must be provided to alert the crew to unsafe system operating conditions and to enable the crew to take appropriate corrective action. A warning indication must be provided if immediate corrective action is required. The design should account for crew alerting cues, corrective action required, and the capability of detecting faults.

6.6.3.2. Cautions. A caution is required whenever immediate crew awareness is required and timely subsequent crew action may be required. A means shall be provided to advise the flightcrew of failed airplane system elements that affect the decision to continue or discontinue the approach.

The guidance or control system shall indicate to the flightcrew when the Actual Navigation Performance (ANP) exceeds the RNP.

Deviation alerting. The FAA does not require excessive deviation alerting, but will approve systems that meet appropriate criteria. If a method is provided to detect excessive deviation of the airplane, laterally and vertically during approach to touchdown and laterally after touchdown, then it should not require excessive workload or undue attention. This provision does not require a specified deviation alerting method or annunciation, but may be addressed by parameters displayed on the ADI, EADI, HUD, or PFD. When a dedicated deviation alerting is provided its use must not cause excessive nuisance alerts.

For systems demonstrated to meet criteria for Category II, compliance with the following criteria, from JAA/AWO 236, is an acceptable means of compliance, but is not a required means of compliance:

a) For systems meeting the AWO 236 criteria, excess-deviation alerts should operate when the deviation from the ILS or MLS glide path or localizer centerline exceeds a value from which a safe landing can be made from offset positions equivalent to the excess-deviation alert, without exceptional piloting skill and with the visual references available in these conditions.

b) For systems meeting the AWO 236 criteria, excess-deviation alerts should be set to operate with a delay of not more than one (1) second from the time that the deviation thresholds are exceeded.

c) For systems meeting the AWO 236 criteria, excess-deviation alerts should be active at least from 300 feet HAT (90 m) to the decision height, but the glide path alert should not be active below 100 feet HAT (30 m).

6.6.3.3. System Status. Appropriate system status and failure annunciations suited to the guidance systems used, navigation sensors used, and any related aircraft systems (e.g., autopilot, flight director, electrical system) should be provided for the operator to determine prior to departure and the flightcrew to determine after departure, the capability of the airplane approach system components to accomplish the intended approach.

a. While en route, the failure of each airplane component affecting the approach capability should be indicated without flightcrew action. The indication should be an advisory (i.e. not a warning or caution, annunciates without flightcrew action, but does not demand immediate flightcrew attention), unless the failure requires a warning or caution for other reasons (e.g., autopilot disconnect warning).

b. A means shall be provided to advise the flightcrew of failed airplane system elements that affect the decision to continue to the destination or divert to an alternate.

c. System Status indications should be identified by names that are different than operational authorization categories (e.g., do not use names such as “CAT I”, “CAT II”, “CAT III”).

6.7. Multiple Landing Systems and Multi-mode Receivers (MMR) for Category II. International agreements have established a number of landing systems as an acceptable means to provide guidance to support the conduct of an instrument approach. This section identifies unique requirements which relate to airplane systems which provide the capability to conduct approach and landing operations using these multiple landing systems (e.g., ILS, MLS, GNSS Landing System (GLS)). Provisions equivalent to those listed in Appendix 2 Section 6.7, except as appropriate for systems applicable to Category II may be applied.

6.7.1. General Requirements. Where practicable, the flight deck approach procedure should be the same irrespective of the navigation source being used.

A means (for example the current ILS audio idents) should be provided to confirm that the intended approach aid(s) has been correctly selected.

During the approach, an indication of a failure in each non-selected airplane system element must be provided to the flightcrew as an indication of system status; it should not produce a caution or warning.

6.7.2. Indications. The following criteria apply to indications in the flight deck for the use of a multi-mode landing system:

The loss of acceptable deviation data shall be indicated on the display. It is acceptable to have a single failure indication for each axis common to all navigation sources.

6.7.3. Annunciations. The following criteria applies to annunciations in the flight deck when using a multi-mode approach system:

The navigation source (e.g., ILS, MLS, GLS, FMS) selected for the approach shall be positively indicated in the primary field of view at each pilot station,

The data designating the approach (e.g., ILS frequency, MLS channel, GNSS 'path identifier') shall be unambiguously indicated in a position readily accessible and visible to each pilot,

A common set of mode ARM and ACTIVE indications (e.g., LOC and GS) is preferred for ILS, MLS and GNSS operations, and

A means should be provided for the crew to determine a failure of the non-selected navigation receiver function, in addition to the selected navigation receiver function. When considering equipment failures, the failure indications should not mislead through incorrect association with navigation source. For example, it would not be acceptable for the annunciation "ILS FAIL" to be displayed when the selected navigation source is MLS and the failure actually affects the MLS receiver.

6.7.4. Alerting. Flight operations require alternate airports for takeoff, en route diversion and landing. These alternate airports may have different landing systems. Flight operations may be planned, released and conducted on the basis of using one or more landing systems.

a. The capability of each element of a multi-mode approach and landing system shall be available to the flightcrew to support dispatch of the airplane.

b. A failure of each element of a multi-mode approach and landing system must be indicated to the flightcrew without pilot action, as an advisory (i.e. not a warning or caution, does not demand immediate flightcrew attention), during en route operation.

c. A failure of the active element of a multi-mode approach and landing system during an approach shall be accompanied by a warning, caution, or advisory (i.e. not a warning or caution, annunciates without flightcrew action, but does not demand immediate flightcrew attention), as appropriate.

d. An indication of a failure in each non-selected element of a multi-mode approach and landing system during an approach may be made available to the flightcrew as an advisory (i.e. not a warning or caution, annunciates without flightcrew action, but does not demand immediate flightcrew attention),but should not produce a caution or warning.

6.7.5. Multi-mode Receivers (MMR) used for systems for Category II. For MMRs used for systems for Category II, using more than one or more type(s) of landing system, the means of compliance required for certification can be simplified, provided the applicant provides appropriate justification. This section provides guidance for retrofit certifications, for "ILS Look alike" applications, and for certification of ILS installations with either new or modified receivers. Equivalent provisions as to those described in Appendix 2 Section 6.7.5 , except as applicable to criteria for Category II may be applied.

7. APPROACH SYSTEM EVALUATION. An evaluation should be conducted to verify that the pertinent systems as installed in the airplane meet the airworthiness requirements of section 6 of this appendix. The evaluation should include verification of approach system performance requirements and a safety assessment for verification of the integrity and availability requirements. Engine failure cases and other selected failure conditions identified by the safety assessment should be demonstrated by simulator and/or flight tests.

An applicant shall provide a certification plan(s) that describes:

a) The means proposed to show compliance with the requirements of section 6 of this appendix, with particular attention to methods that differ significantly from those described in this appendix.

b) How any non-airplane elements of the Approach System relate to the airplane system from a performance, integrity and availability perspective (e.g., appropriate reference to ICAO Annex or United States Standard).

c) The assumptions on how the performance, integrity and availability requirements of the non-airplane elements of non-Standard Landing Aids will be assured.

d) The system concepts and operational philosophy to allow the regulatory authority to determine whether criteria and requirements in excess of that contained in this appendix are necessary.

Early agreement between the applicant and the FAA should be reached on the proposed certification plan. Upon completion of an FAA engineering design review and supporting simulation studies, a type inspection authorization (TIA) should be issued to determine if the complete installation of the equipment associated with Category II operations meets the criteria of this appendix.

7.1. Performance Evaluation Performance for an airborne system intended to meet provisions of this Appendix should be demonstrated by flight test.

The airborne system should be demonstrated in at least the following conditions taking into account manual/coupled autopilot, autothrottle configurations for Category II approaches:

a. Wind Conditions:

20 kts - Head wind component

10 kts - Crosswind component

10 kts - Tailwind component

ATS reported surface winds, or equivalent, may be used.

b. Performance shall be demonstrated by flight test, or analysis validated by flight test, using at least 3 different representative facilities for a minimum of 20 total approaches, with a representative range of environmental and system variables which have an effect on overall performance.
If more than 1 approach in the series of approaches attempted are unsuccessful, an additional number of successful approaches may be required, as agreed by the applicant and FAA. When applied to path vertical tracking in conjunction with Category III, momentary excursions up to ±75 microamps during test demonstrations may be acceptable if flight guidance system touchdown and landing performance is otherwise shown to be satisfactory.

FAA will accept use of the Continuous Method and the Pass/Fail Method, found in JAR ACJ AWO 231, in lieu of the 95% of the time per approach described in sub-sections of 6.2, and the minimum number of 20 approaches stated above.

7.2. Safety Assessment. Except as required by any specific safety related criteria identified in this appendix, or by the operating rules, a safety assessment of the Approach system, considered separately and in conjunction with other systems, shall be conducted to show compliance with section 25.1309.

8. AIRBORNE SYSTEM REQUIREMENTS. This section identifies criteria applicable to specific aircraft system architecture selected to conduct the operation. This criteria is developed from operational considerations, approach system considerations, airplane system considerations and the general operational philosophy contained in the body of this AC.

8.1. General. Various airplane systems are expected to comply with the basic performance, integrity and availability requirements are identified in Section 6 of this Appendix.

8.2. Autopilot. The following criteria is applicable to Autopilot systems:

The suitability of pertinent autopilot modes or features applicable to conducting or monitoring an approach, landing, rollout or go around, as applicable, should be considered in showing compliance with section 25.1523.

The autopilot must not have normal features or performance, or performance in typical adverse environmental conditions which would cause undue crew concern and lead to disconnect (e.g., inappropriate response to ILS beam disturbances or turbulence, unnecessarily abrupt flare or go-around attitude changes, unusual or inappropriate pitch or bank attitudes, or sideslip response).

Control of Approach Flight Path. - the autopilot must:

1) maintain the approach path,

2) if applicable, make the alignment with the runway, flare and land the airplane within the prescribed limits, or

3) promptly go-around, with minimum practical loss of altitude.

Autopilot performance must be compatible with either manual speed control, or if applicable, autothrottle speed control.

Mode definition and logic should be consistent with appropriate industry practice for mode identification and use (e.g., naming, mode arming and engagement). Definition of new modes or features, not otherwise in common use, should be consistent with their intended function, and consider potential for setting appropriate or adverse precedent.

The autopilot system performance and alerting should be consistent with the intended operational use for duties and procedures of the pilot flying (PF) and pilot not flying (PNF) (see sections 5.6 and 5.8 of the main body of this AC).

If the autopilot is used to control the flight path of the airplane to intercept and establish the approach path, the pilot should be able to transition from automatic to manual flight at any time without undue effort, attention, or control forces, and with a minimum of disturbance of flight path.

If a HUD is installed, any transition from autopilot to HUD guidance or vice versa, must not require exceptional piloting skill, alertness, strength or excessive workload.

A flight director system, or alternative form of guidance, if used, must be compatible with the autopilot and vice versa.

A fault must cause an autopilot advisory, caution, or warning, as necessary. If a warning is necessary, the pilot must be able to detect the warning with a normal level of attention and alertness expected during an approach or go-around.

8.3. Head Down Guidance. The following criteria is applicable to Head Down Guidance systems:

A flight director system, or alternative form of guidance, must be designed so that the probability of display of incorrect guidance commands is Remote.

Wherever practical, a fault must cause guidance information to be immediately removed from view. If a warning is given instead, it must be such that the pilot will observe the warning while using the information.

8.4. Head Up Guidance. The following criteria is applicable to Head Up Guidance systems:

a. The workload associated with use of the HUD should be considered in showing compliance with section 25.1523.

b. The HUD display medium must not significantly obscure the pilot's view through the cockpit window.

c. Control of Approach Flight Path - the HUD must provide sufficient guidance information, without excessive reference to other cockpit displays, to enable a suitably trained pilot to:

(1) maintain the approach path,

(2) go-around.

d. The pilot should be able to align with the runway without the HUD adversely affecting the pilot task. If command information is provided for the flare and landing, it must not be misleading and should be consistent with the characteristics of normal manual maneuvers.

e. If only one HUD is installed, it should be installed at the pilot-in-command crew station.

f. The HUD guidance must not require exceptional piloting skill to achieve the required performance.

g. The HUD system performance and alerting should be consistent with the intended operational use for duties and procedures of the pilot flying (PF) and pilot not flying (PNF) (see sections 5.6 and 5.8 of the main body of this AC).

h. If the autopilot is used to control the flight path of the airplane to intercept and establish the approach path, the point during the approach at which the transition from automatic to manual flight takes place shall be identified and used for the performance demonstration.

i. Any transition from autopilot to HUD guidance must not require exceptional piloting skill, alertness, strength or excessive workload.

j. A flight director system, or alternative form of guidance, must be designed so that the probability of display of incorrect guidance commands is Remote.

k. Wherever practical, a fault must cause guidance information to be immediately removed from view. If a warning is given instead, it must be such that the pilot will observe the warning while using the information.

8.5. Hybrid HUD/Autoland Systems [PoC]. The following criteria is applicable to Hybrid systems:

a. If a HUD is used to monitor an autoflight system, it should be shown to be compatible with the autoflight system and permit a pilot to detect unsuitable autopilot performance.

b. Other hybrid systems (e.g., including EVS) require a proof of concept **[PoC]** evaluation to establish suitable criteria.

8.6. Satellite Based Approach System. The following criteria is applicable to Satellite Based Approach systems:

a) Satellite based systems should be shown to provide equivalent or better capability than navigation systems based on VOR, DME, or ILS for comparable operations, or meet provisions applicable to RNP.

b) Satellite based systems should not exhibit undue sensitivity to masking of satellite vehicles, or interference from onboard or external sources.

c) Satellite based systems should not exhibit adverse characteristics during acquisition or loss of satellites.

8.7. Reserved.

8.8. Autothrottle. For Category II, an autothrottle should meet the provisions of Appendix 2 Section 8.8, and in addition:

a. Hold speed within ± five knots of the intended speed, except for momentary gusts, , in typical environmental conditions expected for use, and

b. Provide appropriate status, advisory, caution and warning information for failures, and

c. Provide timely application of "Go-around thrust" if a go-around mode is available, and

d. Not require undue crew attention or skill to recognize and respond to an engine failure during approach or go-around.

8.9. Datalink [PoC]. A data link may be used to provide data to the airplane to provide the accuracy necessary to support the approach.

a. The integrity of the data link should be commensurate with the integrity required for the approach.

b. The role of the data link in the approach system must be addressed as part of the aircraft system certification process until such time as an acceptable national, or international standard, for the ground system is established.

9. Airplane Flight Manual. The Airplane Flight Manual should contain the following information:

a. Any conditions or constraints on Approach performance with regard to Airport conditions (e.g., elevation, ambient temperature, approach path slope, runway slope and ground profile under the approach path).

b. The criteria used for the demonstration of the system, acceptable normal and non-normal procedures, the demonstrated configurations, and types of facilities used, and any constraints or limitations necessary for safe operation.

c. The type of navigation facilities used as a basis for certification. This should not be taken as a limitation on the use of other facilities. The AFM may contain a statement regarding the type of facilities or condition known to be unacceptable for use.

d. Information should be provided to the flightcrew regarding atmospheric conditions under which the system was demonstrated e.g., headwind, crosswind, tailwind etc. The AFM should contain a statement that "Credit may not be predicated on the use of <type of system> if conditions exceed … (those for which the system received airworthiness approval).

Note 1: The AFM limitation section should not specify DA(H) or RVR limitations.

Note 2: AC 25.1581-1 Section 2 discusses AFM contents. The approval status referenced in 2 b (9) (vii) for Category I, II, or III of that AC should be noted in the Normal Procedures Section of the AFM, in accordance with the above provisions.

APPENDIX 4.
WIND MODEL FOR APPROACH SIMULATION

Wind models need not be applied to obtain approval of systems related to Appendix 2 or Appendix 3. However, if the applicant elects to use simulation with a wind model to support approval, it is recommended that the model specified in AC 120-28D is used.

APPENDIX 5

OBSTACLE ASSESSMENT FOR RNP FOR CATEGORY I OR CATEGORY II

1. Obstacle Assessment for Standard RNP Types (e.g., Linear Values of RNP).

1.1. Obstacle Assessment for Required Navigation Performance Approaches and Missed Approaches.

1.1.1. General. This Appendix provides standard criteria that may be used in the development of RNP approaches by FAA procedure designers and Designated Procedure Design Representatives. It also provides a standard criteria that may be used in lieu of the above criteria when it is desired to use ILS/or ILS equivalent criteria. These criteria may be used in conjunction with airworthiness demonstrations of airborne equipment, or in the assessment of other States criteria used in international operations for U.S. Operators.

The approach RNP is specified from the FAF to the point along the final approach segment at which the lowest applicable DA(H) typically is applied. There may be one or more levels of RNP specified on a final segment. Missed approach RNP, or levels of RNP if more than one level or RNP is specified, is typically specified from a point related to the lowest applicable DA(H), and typically continues to a missed approach holding fix or missed approach waypoint. RNP also may be applied to a "go-around safety" assessment.

When applied to a "go-around safety assessment" the RNP level and associated obstacle clearance start at the end of the touchdown zone with an expanding lateral area that widens to match the level of RNP used, and then continues at the RNP level(s) specified. The expanding lateral area starts on the centerline for the approach at the end of the touchdown zone and widens at a 7.5 degree splay. Splay criteria based on ICAO PANS-Ops may alternately be used at the discretion of the procedure designer or operator (e.g., 1:8 splay/ 7.125 degrees). A go-around safety assessment is applicable from the end of a touchdown zone to reaching the missed approach holding fix or applicable missed approach waypoint (See below for specific criteria). When conducting a "go-around safety assessment", the potential growth of ANP following pertinent failures should be appropriately considered, relative to the designated level(s) of RNP in approach or missed approach segments.

Procedures for U.S. air carrier operations (operations conducted in accordance with FAR 121 or 135 should address application of RNP to "go-around safety" (see Section 4.3.1.8 of the main body of this Circular). It is recommended that other operators also address "go-around safety".

1.1.2. Final Approach (FAS), Missed Approach (MAS) and other Related Segments
The criteria presented in this Appendix apply to the Final Approach (FAS) and Missed Approach segments (MAS). The FAS is defined as that segment of an approach extending from the GPIWP or APIWP, whichever occurs later, to GIRP. However, for the purpose of defining RNP obstacle clearance in this appendix, the Final Approach segment (FAS) is considered to begin at the FAF and ends at the FPCP (runway Datum Crossing Height (DCH)), or missed approach point (e.g., DA(H)). No specific minimum or maximum length is assigned to the FAS, but the FAF must be located such that consideration is given to how the FMC VNAV operation may be constrained in certain ways at the point the FAS commences. In addition, consideration should be given in the placement of the FAF recognizing that a continuous VNAV descent may be intended to the FAF, instead of a level intermediate segment with a minimum VNAV intercept altitude. The Missed Approach segment is defined as beginning at a point coincident with the lowest applicable DA(H) and ending at a specified missed approach waypoint (e.g., Initial Missed Approach WP, Missed Approach Holding WP). No minimum or maximum length is assigned to the MAS, but consideration should be given to having the aircraft established on an en route transition. Definitions for various segments used in procedure construction are as specified in Table A5-1 below (Also see AC main body section 4.6, and Appendix 1):

Approach and Missed Approach Segments Applicable To RNAV Instrument Procedures Using RNP

Table A5-1

Final Approach Segment (FAS)	The segment of an approach extending from the Glidepath Intercept Waypoint (GPIWP) or Approach Intercept Waypoint (APIWP), whichever occurs later, to the Glidepath Intercept Reference Point (GIRP). For the purpose of procedure construction, The Final Approach segment is defined as beginning at the FAF and ending at the Flight Path Control Point (FPCP) or point at which the missed approach segment starts (e.g., point of lowest nominal DA(H)).
Extended Final Approach Segment (EFAS)	That segment of an approach, co-linear with the Final Approach Segment, but which extends beyond the Glidepath Intercept Waypoint (GPIWP) or Approach Intercept Waypoint (APIWP).
Runway Segment (RWS)	That segment of an approach from the glidepath intercept reference point (GIRP) to Flight Path Alignment Point (FPAP).
Initial Missed Approach Segment (IMAS)	That segment of an approach from the Glide Path Intercept Waypoint (GIRP) to the Initial Missed Approach Waypoint (IMAWP).
Missed Approach Segment (MAS)	That segment of an instrument approach procedure from a point on the FAS corresponding to the position where the lowest DA(H) occurs under nominal conditions, to the designated IMAWP, or missed approach holding WP, as specified for the procedure.

1.1.3. Approach and Missed Approach Conditions To Be Assessed.
Three basic conditions are considered in the development of obstacle clearance criteria for RNP approaches and missed approaches:

a. The aircraft arrives at the DA(H), continues with visual reference to a landing on the runway.

b. The aircraft arrives at the DA(H), initiates a missed approach, and experiences an engine failure.

c. The aircraft arrives at the DA(H), continues with visual reference to the runway, initiates a rejected landing at the end of the touchdown zone, and experiences an engine failure.

Each of these conditions has associated criteria for lateral and vertical obstacle clearance protection. In addition to these normal and non-normal conditions, rare-normal conditions must be assessed. Unless wind limitations are specified, these rare normal conditions should be considered as a wind from the most adverse direction at the certificated limit for landing, increasing to 50 knots at 1000 feet' AGL. This rare-normal wind condition shall increase at a gradient of 10 knots per 1000 feet up to a maximum of 100 knots from the most adverse direction (i.e., tailwind). However, such conditions need not be considered in combination with non-normal events (e.g., engine failure).

In instances, the normal missed approach path and non-normal missed approach path may be different laterally. In such an event, transition from the normal path to the non-normal path should be considered, including performance or energy state of the aircraft, for engine failures that could occur at various critical points along the normal flight path.

1.1.4. Touchdown Zone.
A touchdown zone (TDZ) typically is considered to be the first 3000' feet of a designated landing runway. When appropriate for the purposes of this provision, operators may propose to use a different designation for a touchdown zone. For example, alternate consideration of a touchdown zone (TDZ) may be appropriate for runways that:

- Are less than 6000' in length and which do not have standard TDZ markings,
- Short runways requiring special aircraft performance information or procedures for landing,
- Runways for STOL aircraft, or
- Runway where markings or lighting dictate that a different TDZ designation would be more appropriate.

1.2. OBSTACLE CRITERIA.

1.2.1. Obstacle Identification Surface Between Point Of Lowest DA(H) and The Runway.

For condition 1.1.3(a), described above, an obstacle identification surface is defined for the visual segment between the DA(H) and the touchdown zone on the runway. This surface originates at the runway threshold and is inclined at an angle 1 degree less than the VNAV angle for the FAS. This surface is bounded laterally by two rays which originate from the center of the runway at a point 1000' from the threshold, splay at an angle of 10 degrees relative to the runway centerline, or FAS, to the DA(H), or the point at which the lateral limit of 2* RNP is reached. Any obstacle that penetrates this obstacle identification surface must as a minimum be identified and published for flightcrew reference (Figure A5-1). Other options to resolve a penetration include increasing a VNAV angle, removing the obstacle, displacing the runway threshold, not implementing the approach, adjusting a lateral path, or implementing various combinations of the above options.

In addition, this area should be free of fixed or movable obstacles (regardless of whether they are or are not present by their aeronautical purpose) at the time an instrument approach is conducted inside the FAF. A procedure should not be authorized with an obstacle in this area unless the presence of the obstacle(s) is specifically reviewed and authorized by FAA, and the flightcrew of the landing aircraft is provided information on the location and nature of the obstacle.

Figure A5-3 shows a method for determination of RNP obstacle clearance for a final segment controlling obstacle between DA(H) and the runway.

1.2.2. Obstacle Identification Surface Between the Point Of Lowest DA(H) and a Missed Approach Waypoint.

For the condition 1.3(b), described above, the lateral containment surface is centered on the FAS and bounded on either side by two parallel lines located at a distance of 2*RNP (Figure A5-2). Within the limits of this containment surface, a variable Required Obstacle Clearance (ROC) must be provided which is a function of altitude and temperature. This ROC is established by a Vertical Navigation Error Budget (VEB) evaluation that characterizes the vertical navigation accuracy of the system and provides a parametric methodology to evaluate procedures and assess the impact of obstacles. For example, the Root-Sum-Square (RSS) of the VNAV performance variables that contribute to errors in the vertical axis include, but are not limited to, horizontal along-track navigation system errors, temperature induced barometric altimetry errors, flight technical errors, static source errors, minimum waypoint resolution, minimum vertical path angle resolution, etc. ROC increases along the FAS from a lower reference point up to the upper elevation reference point typically at the FAF. By subtracting the ROC from the VNAV elevation at defined locations, a sloping Obstacle Identification Surface (OIS) beneath the VNAV path is established. The OIS is anchored by the lower reference point at the path's 250' height above touchdown point and by the upper elevation reference point typically 2000' above field elevation. The DA(H) is defined as the Required Obstacle Clearance plus 50 feet above the point on the OIS where the aircraft must be established in a climb to clear all obstacles. The climb gradient used for this analysis is established for a particular aircraft by evaluating the worst case condition. This may include one-engine inoperative, maximum permissible tailwind, maximum permissible landing weight, icing/temp/altitude degradations, etc. A variable DA(H) may be employed if certain conditions are specifically excluded (e.g., no icing). For Instrument Approaches other than ILS, GLS, or MLS (see 4.3.3), developed by a VEB evaluation, the minimum ROC is 250'.

The methodology for determining the DA(H) is the same regardless of whether the controlling obstacle is in the FAS or MAS.

Figure A5-4 shows a method for determination of RNP obstacle clearance for a missed approach segment controlling obstacle.

Figure A5-5 shows the normal instrument approach case that has neither an approach or missed approach controlling obstacle.

1.2.3. Obstacle Identification Surface Between the End of the TDZ and a Missed Approach Waypoint.
For the condition 1.1.3(c), described above, a lateral containment surface is centered on the MAS and bounded on either side by two rays which originate from a point 200 feet either side of the runway centerline at the end of the TDZ (typically 3000' from the approach end of the runway - see 1.1.4 above). These rays splay at an angle of 7.5^{o} out to a maximum distance from the MAS centerline of 2* RNP. Within the lateral limits of this containment surface, a minimum of 35 feet ROC must be provided below the one engine inoperative net flight path of the aircraft (Figure A5-6). Splay criteria based on ICAO PANS-Ops may alternately be used at the discretion of the procedure designer or operator (e.g., 1:8 splay/ 7.125 degrees). For curved initial missed approach segments (e.g., segments based on an ARINC 424 "RF" leg type), an equivalent lateral splay providing equivalent lateral clearance along the path arc length may be used.

Extreme cold temperature considerations should be assessed for VNAV angles, and safe obstacle clearance assured for any initial or intermediate segments (see section 6.2.13).

1.2.4. FAS Turn Construction.
Final Approach Segment (FAS) turns are constructed using appropriate lateral path guidance algorithms of the navigation system for which the procedure is designed, or by using generic algorithms which take numerous navigation system characteristics representative of the range of systems to be used into consideration.

Navigation database defined turns defined through short leg WP sequences or ARINC 424 "RF" Leg types may also be used. If used, appropriate consideration should be made for anticipated ground speeds to be used, leg sequencing, and for "roll in' and "roll out" of an RF leg. Normally, a RF leg should not be based on an assumed nominal bank angle greater than 25 degrees, to allow for path recovery in the event of path displacement disturbances.

1.2.4.1. FAS Turn Construction for Fly-by Waypoints.
For turns on the FAS (other than for a RF leg), the outside (of the turn) lateral containment surface is constructed via an arc of radius 2* RNP, which is centered on the turn waypoint. For the inside lateral containment surface, the ground speed condition which results in the greatest amount of turn anticipation (earliest departure from and latest return to the FAS centerline) is used for construction. For this condition, the containment surface can be constructed in two ways. The first method uses a straight line which extends between the intersections of the two perpendiculars, located at the start and end points of the turn anticipation arc, and the 2* RNP containment surface which is parallel to the segments before and after the turn waypoint. The second method uses an arc of radius equal to the turn anticipation arc minus 2*RNP (Figure A5-7). For RF legs, the RNP*2 surface is as defined by the specified RNP level.

1.2.4.2. FAS Turn Construction for Fly-over Waypoints.
In the event that this type of turn is required (rare use), the ground speed which results in the greatest amount of overshoot and latest return to the FAS centerline should be determined. For this condition, the outside containment surface is constructed as an arc and straight segment combination parallel to and at a distance of 2* RNP from the computed flight path. The inside containment surface is constructed using the conservative assumption of no overshoot). Given this condition, the containment surface is simply defined as the intersection of the 2* RNP surfaces parallel to the Final Approach Segments (Figure A5-8).

1.2.5. MAS Turn Construction.
MAS turns are constructed in a manner identical to turns in the FAS, unless the turn occurs prior to the point at which the containment surfaces are fully expanded to the 2* RNP value. In this event, only fly-by waypoints should be used because of the complexity which results from constructing the outside containment surface for the fly-over waypoints.

1.2.5.1. MAS Turn Construction for Fly-by Waypoints.
For turns on the MAS, prior to the point at which the containment surfaces are fully expanded to the 2* RNP value, the containment surface should be constructed in the following manner:

- The outside lateral containment surface is constructed by transferring the width of the splay abeam the turn waypoint via an arc to the following segment.
- The arc is of radius equal to the attained half-width of the preceding segment and is centered at the turn waypoint.
- The arc is extended to a line perpendicular to the centerline of the following segment and passing through the turn waypoint.
- The splay is continued from that point by an angle of 7.5 to a distance of 2* RNP from the centerline. To simplify the containment surface construction for the inside of the turn, a straight line is drawn between the earliest point of departure and the latest point of return back to the following segment for the fly-by of the turn waypoint.
- For other than RF legs, the containment surface expands by a 7.5 splay angle using the simplified inside turn approximation as the reference centerline. This splay is continued until reaching the 2* RNP displacement from the reference centerline (Figure A5-9). Splay criteria based on ICAO PANS-Ops may alternately be used at the discretion of the procedure designer or operator (e.g., 1:8 splay/ 7.125 degrees).
- For RF legs, the RNP*2 surface is as defined by the specified RNP level.

1.2.5.2. MAS Turn Construction For Fly-over Waypoints.
Fly-over waypoints are not used for a MAS.

1.2.6. RNP reductions.
RNP reductions on the FAS should be considered based on anticipation of the first longitudinal point where the lower level of RNP is required, and assurance that appropriate alerting can be provided prior to the time the lower level o RNP is needed. No transition area is required. However, the RNP reduction should be located such that consideration is given to the maximum latency of RNP alerting messages, maximum ground speed, crew response time, height of any obstacles immediately beyond the change in RNP, and the one-engine inoperative climb gradient. This distance, "d", is shown in Figure A5-10. RNP increases, particularly on a MAS or at the beginning of a MAS, do not require this special consideration, thus distance "b" in Figure A5-10 could be zero.

RNP reductions are not typically used on a MAS.

1.2.7. Coordinate Systems.
Waypoint coordinates shall be defined in the WGS-84 or NAD-83 coordinate system (or equivalent international system for locations outside the US). Waypoint resolution shall be provided to at least 0.01 arc minutes.

1.2.8. Obstruction and Terrain Charts.
The best source(s) of topographical or obstruction charts that are available should be used.

1.2.8.1. Recommended Use of USGS Charts.
Use of USGS 1:25,000 or 1:24,000 charts (or equivalent) is recommended wherever possible.

1.2.8.2. Vertical Clearance Adjustments for Certain Topographical Charts.
FAA Order 8260.19C assigns an accuracy code of "2C" to the 1:24,000 topographical charts. This does not meet the minimum accuracy standard for a precision final segment of an approach. For this reason, a 40' horizontal and 20 feet vertical adjustment is required to the obstacle values taken directly from the topographical chart. These adjustments are applied in the horizontal and vertical direction that most adversely affects the procedure; i.e., the range is reduced by 40 feet and the height increased by 20 feet.

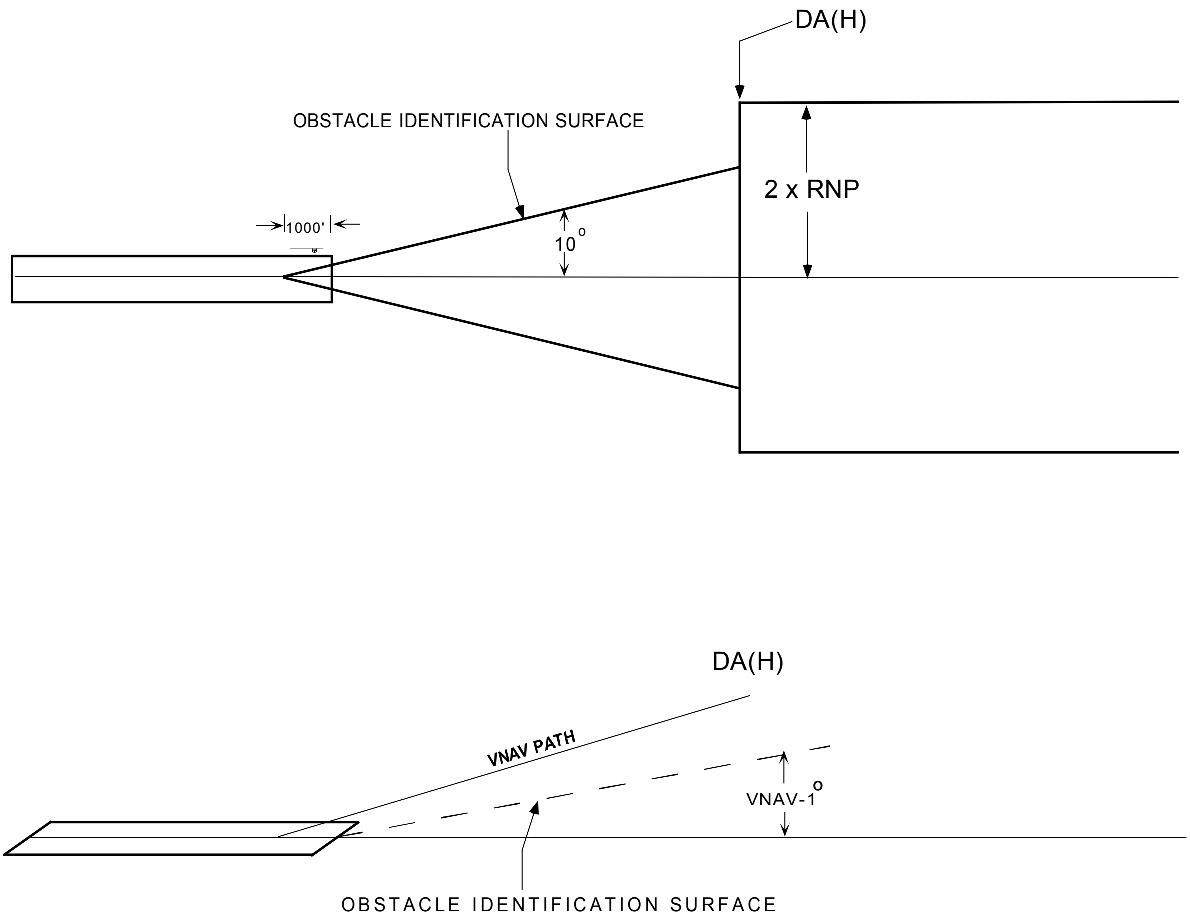
1.2.8.3. Tree Heights.
Tree heights consistent with the maximum found in the area must be added to all contour elevations, unless specific survey heights are used in areas of interest.

1.2.8.4. Assumptions for Terrain Elevations.
Assumptions for terrain elevations should be conservative. If an obstacle of interest falls between two gradient lines, the obstacle should be assigned a height equal to the next higher gradient line minus one unit of elevation. For terrain elevations which are critical (or controlling), the terrain should be assumed to rise to a height equal to the next higher gradient line minus one unit of elevation, at an incremental distance beyond the gradient line in question.

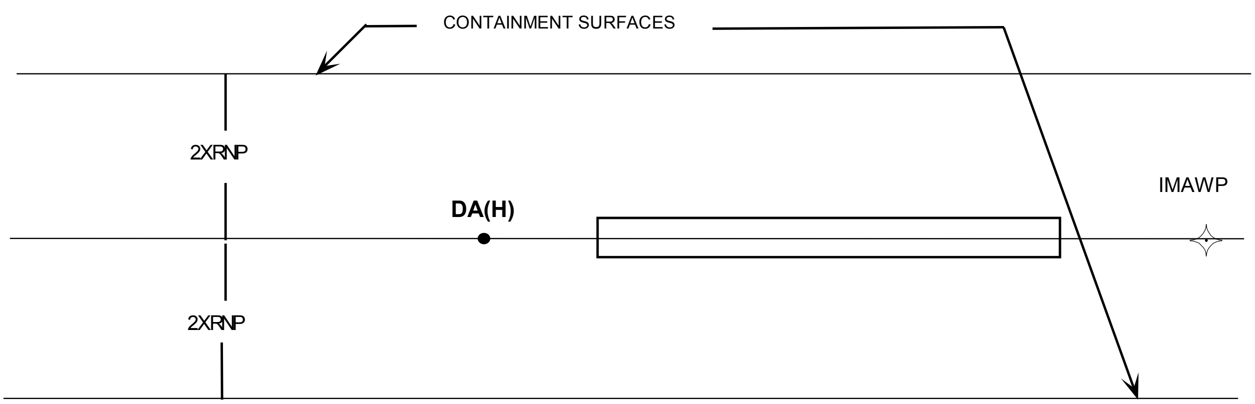
1.2.9. Man-Made Obstacle Data.
Man-made obstacle data may be obtained from the U.S. Department of Commerce Quarterly Obstacle Memo Digital Obstacle File, Airport Obstruction Chart, FAA IAPA database or ICAO equivalent. Horizontal and vertical adjustments are applied as a function of the accuracy code assigned to each obstacle. For areas of interest beyond the Part 77 (or ICAO equivalent) surfaces (e.g. initial and intermediate segments), proper consideration should be made for obstacles which would not be part of the official obstacle records. This consideration may an appropriate additive to all terrain contours or some other equivalent means (e.g. flight inspection or survey).

1.2.10 Wheel To Navigation Reference Point or A Longitudinal Navigation Reference Points.
Aircraft which have a wheel to navigation reference point (e.g., altimeter reference) vertical height less than 19 feet, or a longitudinal navigation reference point (e.g., altimeter reference point) to lowest and most aft wheel distance of 125 feet or less at the normal approach pitch attitude and speed need not account for altimeter vertical and longitudinal displacement from wheel height. Aircraft, which have vertical or longitudinal distances that exceed these values, should include suitable correction factors along with any RSS analysis of potential vertical path displacement errors.

1.3. Examples of completed RNP Forms. Examples of completed FAA Forms 8260 for RNP Procedures are shown in Figures A5-11 and A5-12 for an "RNAV" Procedure with RNP based minima and for an "xLS and RNAV" procedure with RNP based minima.

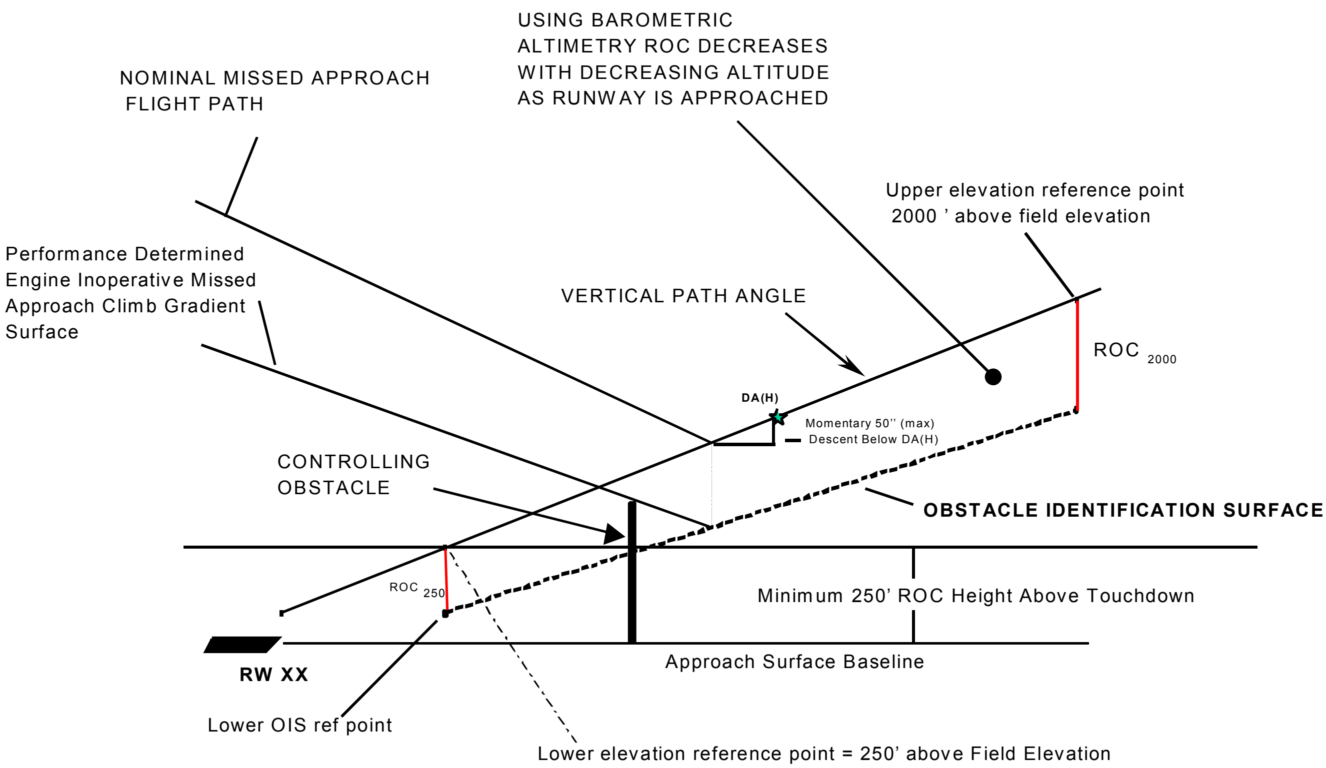


OBSTACLE IDENTIFICATION - VISUAL SEGMENT
Figure A5-1



RNP LATERAL AREA TO CONSIDER - MISSED APPROACH FROM DA(H)
Figure A5-2

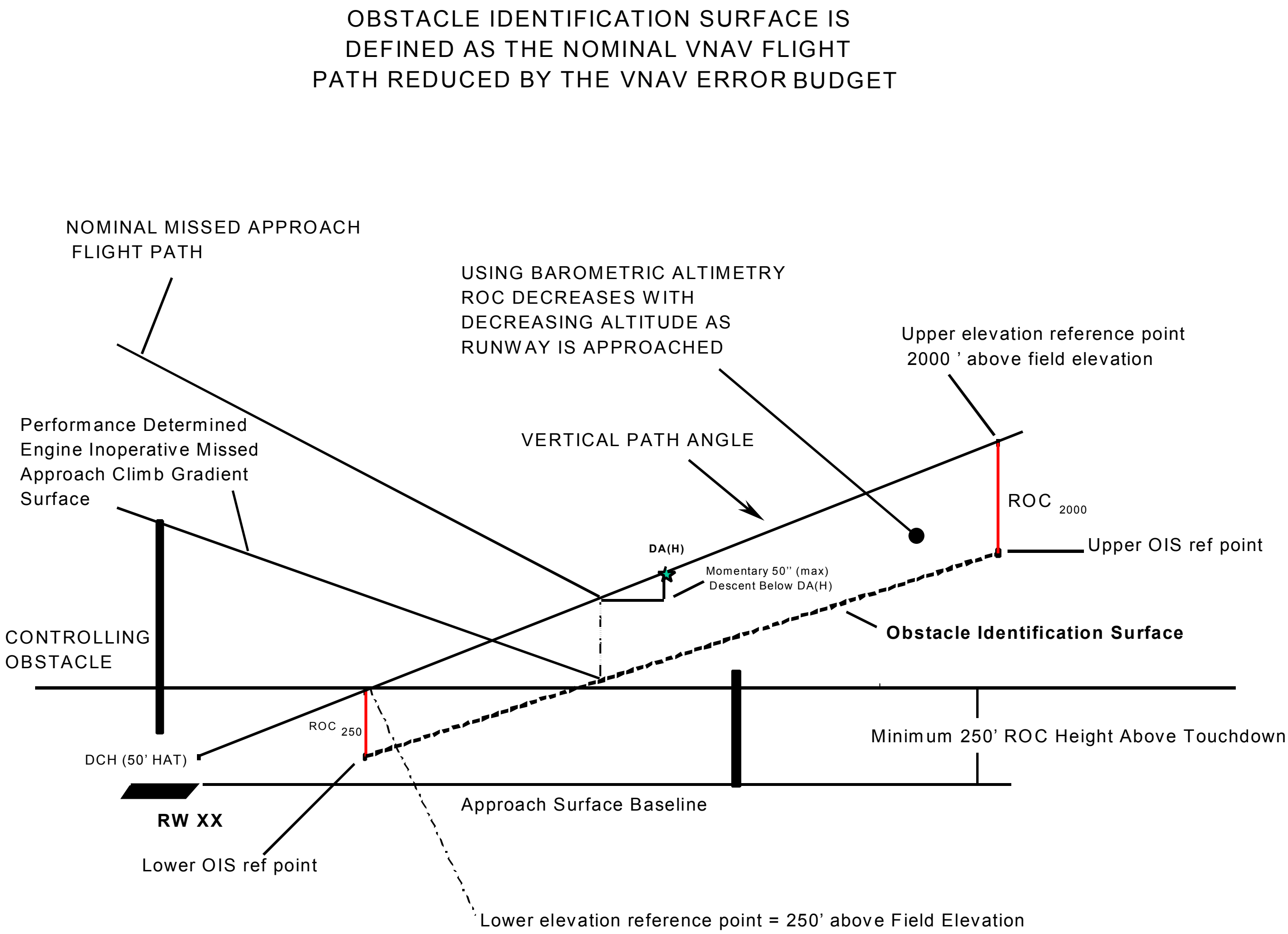
OBSTACLE IDENTIFICATION SURFACE IS
DEFINED AS THE NOMINAL VNAV FLIGHT
PATH REDUCED BY THE VNAV ERROR BUDGET



- DA(H) DETERMINED BY AIRCRAFT PERFORMANCE.
- ASSUMING WORST-CASE CUMULATIVE VNAV ERRORS AIRCRAFT WOULD BE STARTING MISSED APPROACH FROM THE OIS AND CLIMBING ON THE ENGINE INOPERATIVE MISSED APPROACH CLIMB GRADIENTSURFACE
- THE 'ENGINE INOPERATIVE MISSED APPROACH' CLIMB GRADIENT SURFACE MUST CLEAR ALL OBSTACLES

RNP OBSTACLE CLEARANCE - FINAL SEGMENT
CONTROLLING OBSTACLE (BETWEEN THE DA(H) AND THE RUNWAY)

Figure A5-3

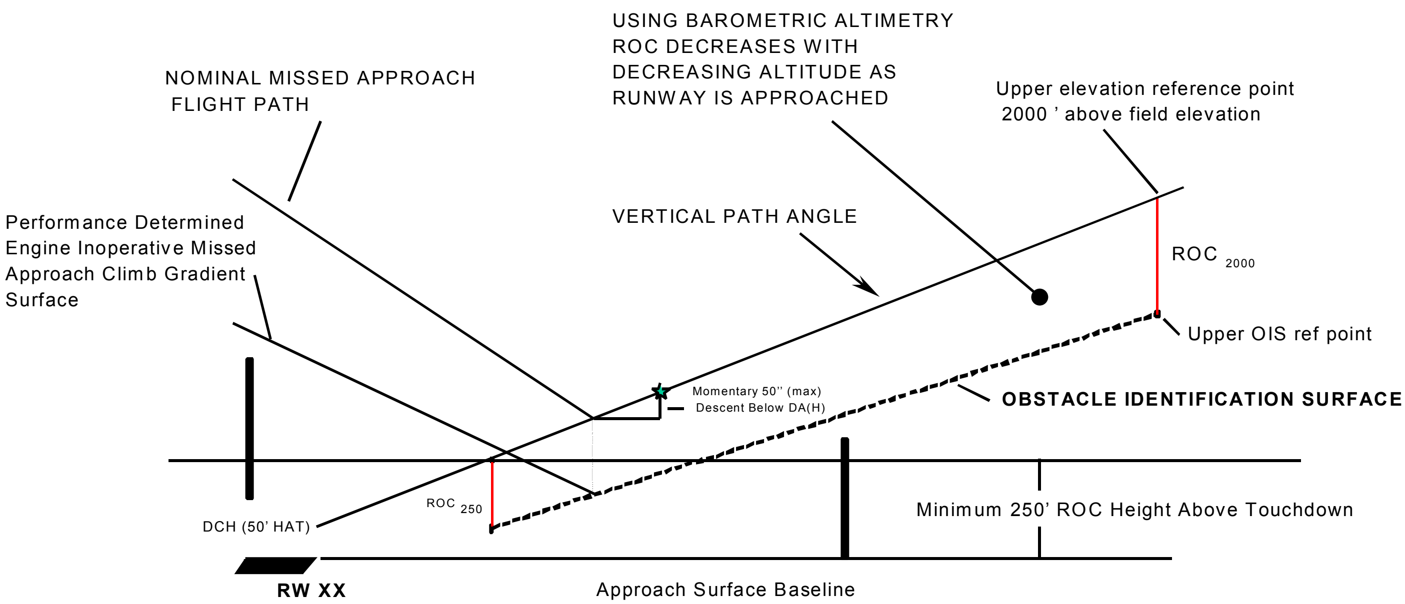


- DA(H) DETERMINED BY AIRCRAFT PERFORMANCE.
- ASSUMING WORST-CASE CUMULATIVE VNAV ERRORS AIRCRAFT WOULD BE STARTING MISSED APPROACH FROM THE OIS AND CLIMBING ON THE ENGINE INOPERATIVE MISSED APPROACH CLIMB GRADIENTSURFACE
- THE 'ENGINE INOPERATIVE MISSED APPROACH' CLIMB GRADIENT SURFACE MUST CLEAR ALL OBSTACLES

RNP OBSTACLE CLEARANCE - MISSED APPROACH SEGMENT CONTROLLING OBSTACLE

Figure A5-4

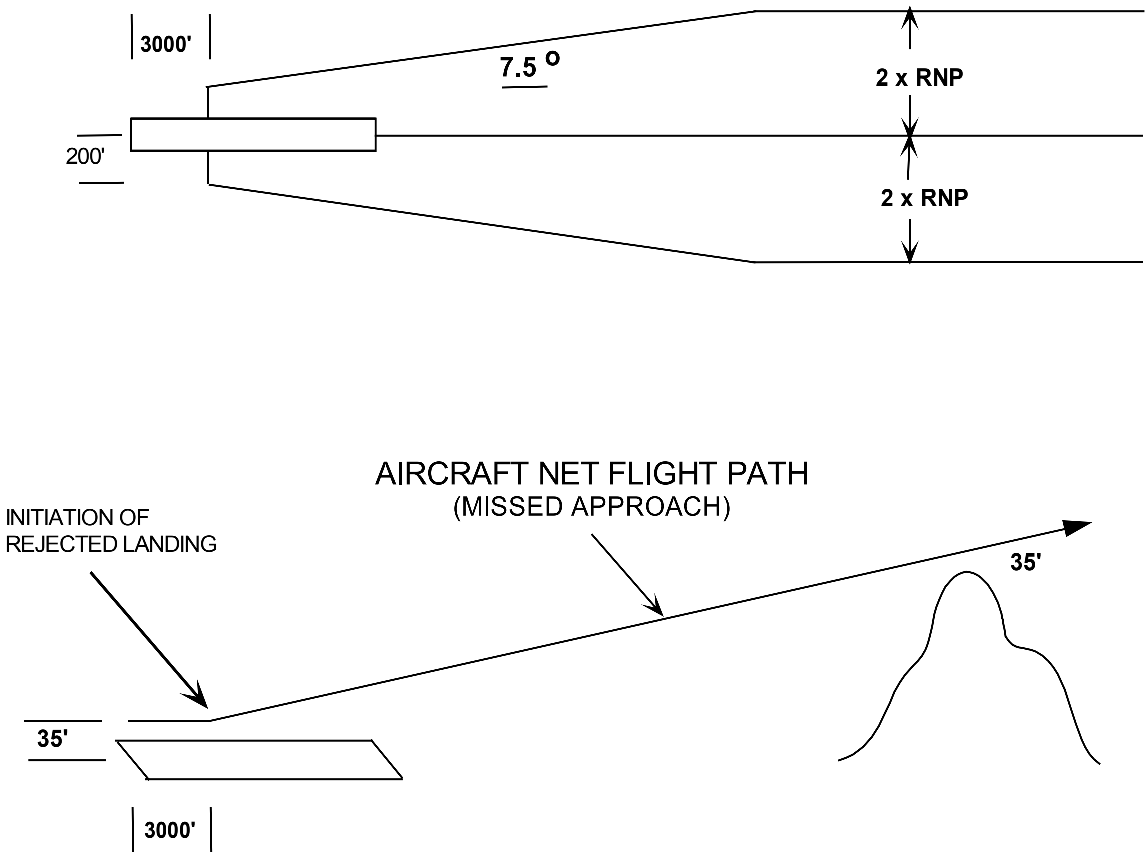
OBSTACLE IDENTIFICATION SURFACE IS DEFINED AS THE NOMINAL VNAV FLIGHT PATH REDUCED BY THE VNAV ERROR BUDGET



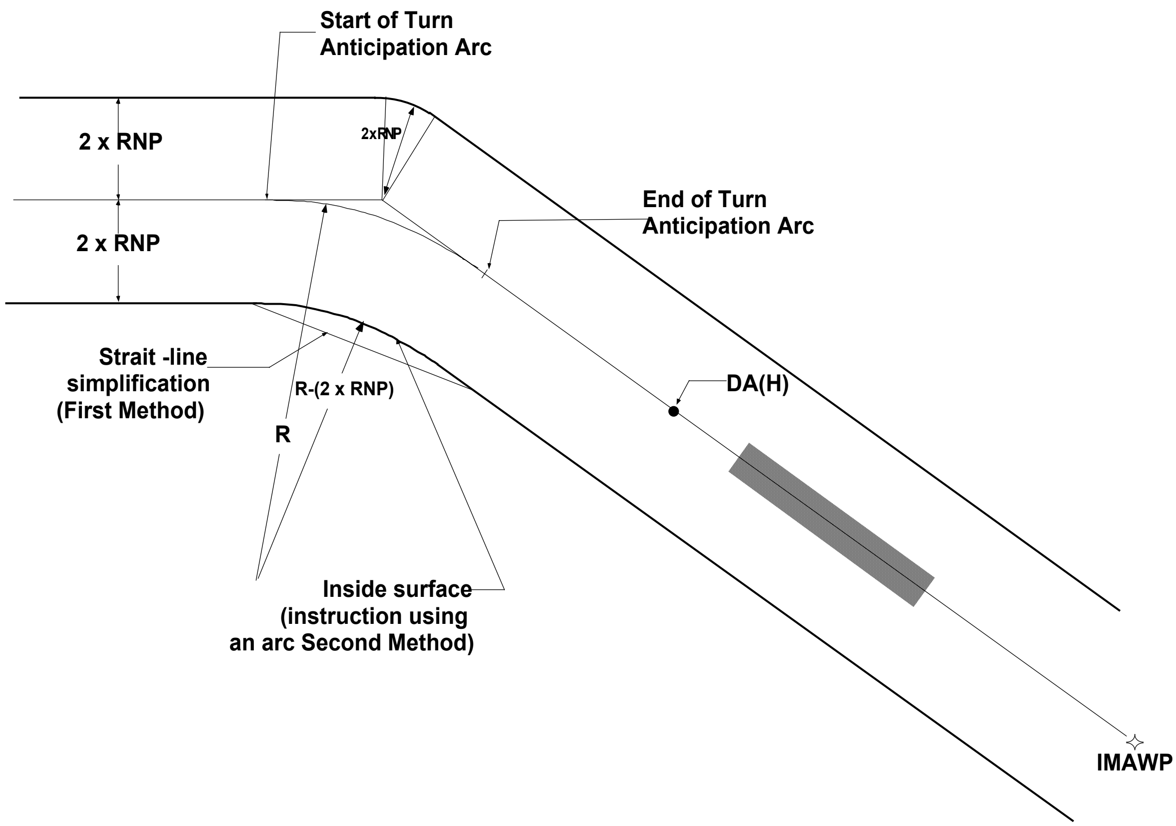
- DA(H) DETERMINED BY AIRCRAFT PERFORMANCE.
- ASSUMING WORST-CASE CUMULATIVE VNAV ERRORS AIRCRAFT WOULD BE STARTING MISSED APPROACH FROM THE OIS AND CLIMBING ON THE ENGINE INOPERATIVE MISSED APPROACH CLIMB GRADIENTSURFACE
- THE 'ENGINE INOPERATIVE MISSED APPROACH' CLIMB GRADIENT SURFACE MUST CLEAR ALL OBSTACLES

RNP OBSTACLE CLEARANCE - NO CONTROLLING OBSTACLE

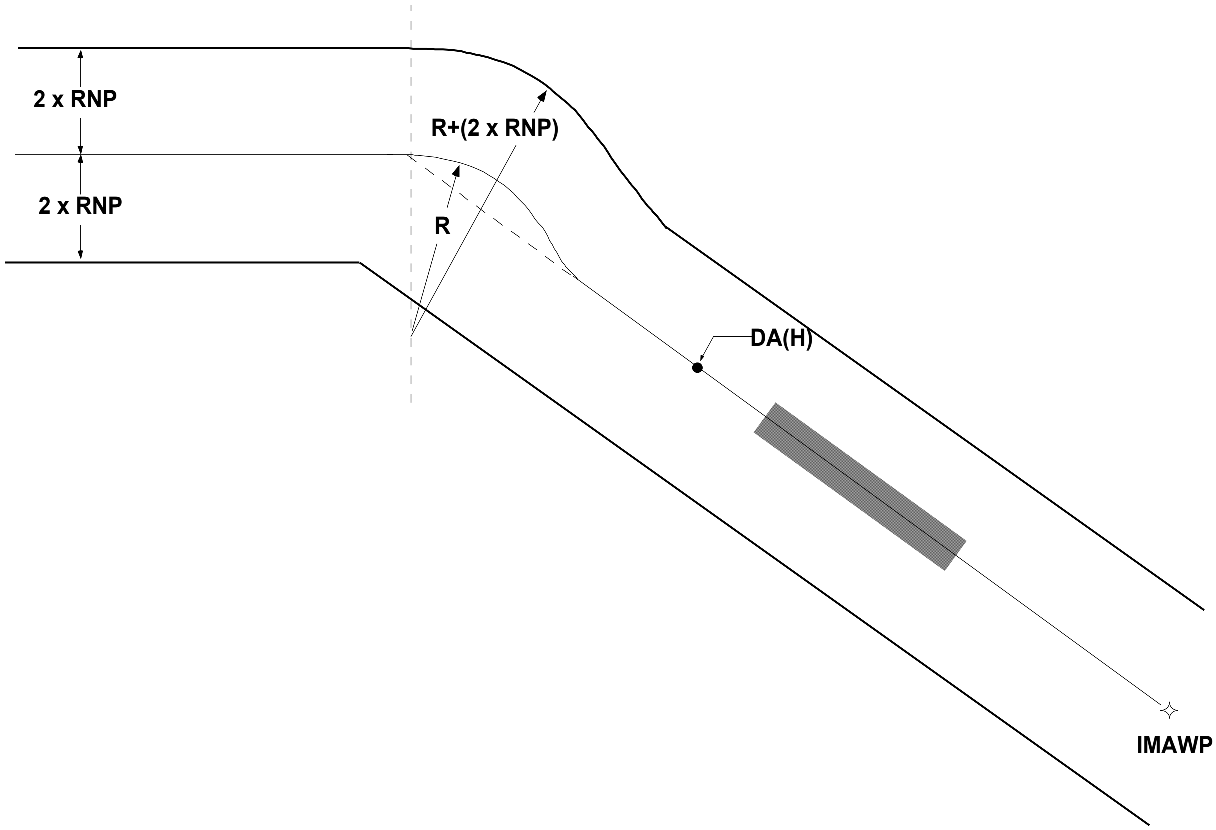
Figure A5-5



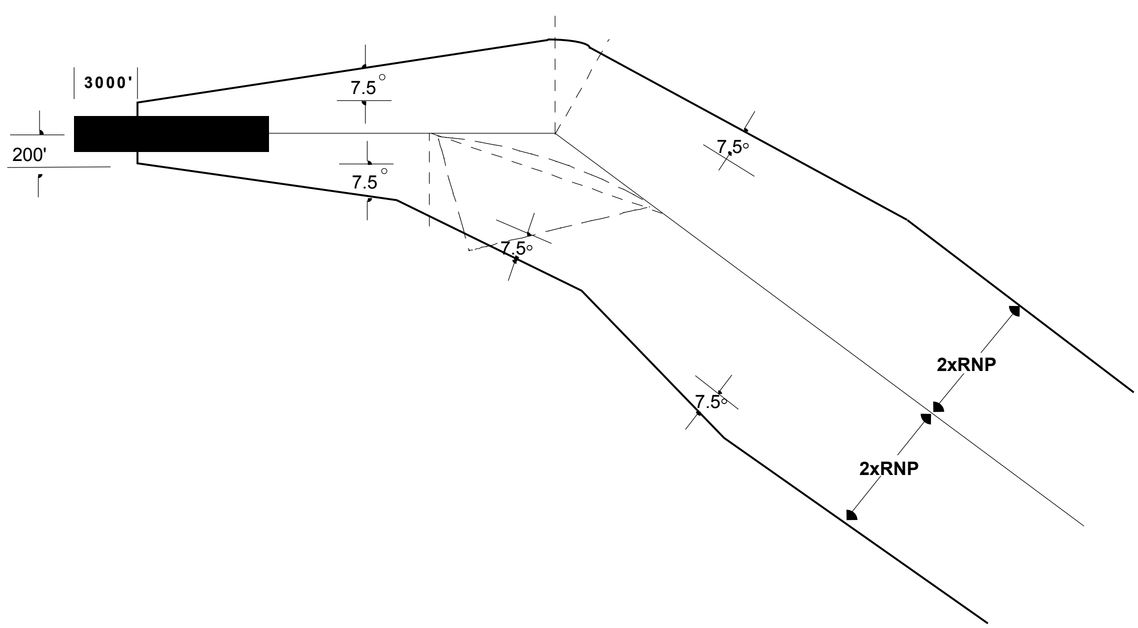
RNP LATERAL AREA TO CONSIDER - REJECTED LANDING
Figure A5-6



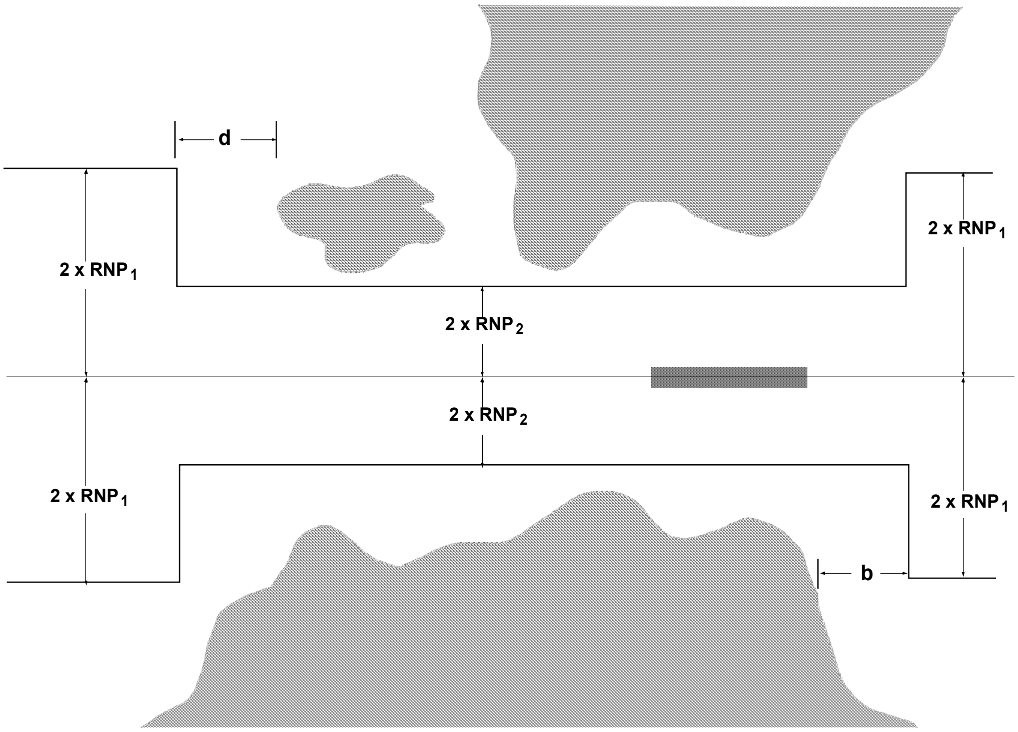
RNP LATERAL AREA TO CONSIDER - TURNS
Figure A5-7



RNP LATERAL AREA TO CONSIDER - "FLY OVER WAYPOINTS"
Figure A5-8



RNP LATERAL AREA TO CONSIDER - REJECTED LANDING (WITH TURNS)
Figure A5-9



RNP LATERAL AREA TO CONSIDER - CHANGE OF RNP TYPE
Figure A5-10

SAMPLE OF A COMPLETED FAA FORM 8260-7
Instrument Approach Procedure - RVAV with RNP Based Minima
(Side 1)

RNP RNAV

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION -- FLIGHT STANDARDS SERVICE
SPECIAL INSTRUMENT APPROACH PROCEDURE -- FLIGHT STANDARDS SERVICE

Bearings, headings, courses, and radials are magnetic. Elevations and altitudes are in feet, MSL, except HAT, HAA, TCH, and RA. Altitudes are minimum altitudes unless otherwise indicated. Ceilings are in feet above airport elevation. Distances are in nautical miles unless otherwise indicated, except visibilities which are in statute miles or in feet RVR.

If an instrument approach procedure of the above type is conducted at the below named airport, it shall be conducted in accordance with a charted instrument approach procedure predicated on the specifications contained herein, unless an approach is conducted in accordance with a different procedure for such airport authorized by the Administrator. Minimum altitudes shall correspond with those established for en route operation in the particular area or as set forth below.

TERMINAL ROUTES

FROM	TO	COURSE AND DISTANCE	ALTITUDE
CASHS WP	RW7B WP	017.54/14.82	6600
RW7B WP (IAF)	MA30B WP	185.55/4.70	4400
MA30B WP	MA30A WP	174.02/4.92	GP3100
MA30A WP	RW7A WP	127.16/3.92	GP1870
RW7A WP	RW07 WP	070.99/1.96	GP1253

MISSED APPROACH

MAP: AT THE DA(H)

CLIMB TO 4000' VIA THE RNP RNAV MISSED APPROACH TRACK TO CRUMM WP AND HOLD

1. PT R SIDE OF COURSE 005.52 OUTBOUND 5700' FT WITHIN 10 MILES OF RW7B WP (IAF)
2.
3. FAC: VARIES FAF: MA30A WP DIST FAF TO MAP: 5.20 THLD: 5.88
4. MIN. ALT: MA30B WP 4400', MA30A WP 3100', RW7A WP 1870'
5. DIST TO THLD FROM OM: MM: IM: 150 HAT: 100 HAT: GS ANT:
6. MIN GS INCPT: 3100' GS ALT AT: OM: MM: IM:
7. GS ANGLE: 3.00 TCH: 50'
8. MSA FROM: RW07 WP: 360-090: 5500'; 090-180: 7700'; 180-360: 10600'

ADDITIONAL FLIGHT DATA:
CRUMM WP: SOUTHEAST, RIGHT TURNS, 274 DEGREES INBOUND; 4000'

MAG VAR: 19E EPOCH YEAR: 1995

MINIMUMS

TAKEOFF: STANDARD SEE NOTES ALTERNATE: N A

CATEGORY	A			B			C			D			E		
	DH/ MDA	VIS	HAT/HAA	DH/ MDA	VIS	HAT/ HAA	DH/ MDA	VIS	HAT/ HAA	DH/ MDA	VIS	HAT/ HAA	DH/ MDA	VIS	HAT/ HAA
S-RNP 0.3/VNAV				1495	3/4	268									

NOTES: SPECIAL AIRCREW TRAINING REQUIRED
FOR USE BY SLANT E (/E), DUAL GPS EQUIPPED, RNP CERTIFIED AIRCRAFT ONLY
CIRCLING NOT AUTHORIZED

CHART THE FOLLOWING NAVAIDS: WENATCHEE VOR 111.0 EAT

BALL TAG 1: MAX HOLDING SPEED 230 KTS

APPROACH FEEDER SEGMENTS ARE ALL RNP 0.5
APPROACH AND MISSED APPROACH SEGMENTS ARE ALL RNP 0.3

FOR INOPERATIVE ODALS, INCREASE CAT B VISIBILITY TO 1 MILE

CITY AND STATE	ELEVATION: 1245' TDZE: 1203' AIRPORT NAME:	FACILITY IDENTIFIER:	PROCEDURE NO. / AMDT NO. / EFFECTIVE DATE:	SUP: NONE AMDT: DATED:
WENATCHEE, WA	PANGBORN MEMORIAL	RNV07	RNP RNAV RWY 07, ORIGINAL	

FAA FORM 8260 - 7 / February 1995 (computer generated) PAGE 1 OF 1 PAGES

Figure A5-11

(Cont.) SAMPLE OF A COMPLETED FAA FORM 8260-7
Instrument Approach Procedure - RVAV with RNP Based Minima
(Side 2)

NOTES CONTINUED: MISSED APPROACH

FROM	TO	COURSE AND DISTANCE
RW07 WP	RW30B WP	104.07/4.59
RW30B WP	SHAKER WP	126.57/2.85
SHAKER WP	CRUMM WP	93.87/5.72

AIR CARRIER NOTES:

The procedure on the other side and the foregoing data are hereby:

FLIGHT CHECKED BY

NAME:	FIFO	DATE:

DEVELOPED BY

NAME:	FIFO	DATE:

RECOMMENDED BY

NAME: MANAGER	FIFO	DATE:

APPROVED BY

NAME:	REGION, FLT STANDARDS	DATE:

OPERATIONS SPECIFICATIONS -- AIRPORT

________________ holding Air Carrier Operating Certificate No. ________________ hereby acknowledges receipt of Operations Specifications to operate into and out of the airport named on the other side ☐ Regular, ☐ Refueling, ☐ Alternate ☐ Provisional for ________________ airport with the following type aircraft:

Unless otherwise authorized in the Operations Specifications - Airport, an instrument approach of this type shall be conducted in accordance with the procedure specified on the other side and the air carrier minimums specified above with the following exceptions:

DATE: ____________ RECEIVED FOR THE AIR CARRIER BY: ________________ TITLE: ________________
SIGNATURE

AMENDMENT NO. ____________

BY DIRECTION OF THE ADMINISTRATOR ________________ ________________
SIGNATURE TITLE

EFFECTIVE DATE: ____________

Figure A5-12

2. Final Approach Obstacle Assessment - Non-Standard Levels of RNP

2.1 OBSTACLE ASSESSMENT FOR NON-STANDARD LEVELS OF RNP

Category I or Category II instrument approach procedures may be based on various criteria for obstacle clearance including FAA AC120-29 as amended, Standards for Terminal Instrument procedures (FAA Order 8260.3 TERPS), ICAO PANS-OPS, or other state criteria for operations within those States. Category I or II operations may also be based on Non-Standard Levels or Types of RNP when approved by FAA.

2.2. OBSTACLE CRITERIA.

2.2.1. The obstacle assessment criteria described below may be used for Category I or Category II procedures which are based on ILS, MLS, GLS (GNSS/Differential GNSS) or other systems which provide equivalent performance.

2.2.2. Airborne Systems previously assessed against earlier criteria of Advisory Circular (AC) 120-29 through Change 3, or Systems for Category III assessed using AC 120-28 through AC 120-28C or equivalent ILS/MLS criteria (BCARs, JAR, etc.) are considered to have met the criteria below, without further demonstration.

2.2.3. Airborne systems may be demonstrated to successfully perform to a value of HAT other than the lowest applicable standard HAT (e.g., 100 feet' HAT for Cat II; or 200 feet HAT for Cat I). When such demonstrations (e.g., for FMS) are conducted, the operational DA(H) authorized may be limited to corresponding higher minima, based on the lowest HAT successfully demonstrated (e.g., 250 feet HAT, 300 feet HAT).

2.2.4. While the criteria of this appendix is primarily intended for Category I or Category II, it also may have other applications such as for assuring acceptable performance along the final approach segment of a Category III procedure, down to 100 feet HAT.

2.3. USE OF THESE CRITERIA FOR AIRBORNE SYSTEM AIRWORTHINESS DEMONSTRATIONS WITH NON-STANDARD LEVELS OF RNP. When this criteria is used in conjunction with airworthiness demonstrations of airborne systems using Non-Standard RNP Criteria, the following assumptions should be applied, unless use of other assumptions is determined to be acceptable to FAA.

2.3.1. LATERAL PERFORMANCE.

2.3.1.1. The lateral dimensions defined by containment should contain the structure of the aircraft, except that compensation for varying pitch attitudes, bank angles, or yaw/drift angles during approach need not be applied. A maximum wing semi-span of 115 feet may be assumed.

2.3.1.2. The lateral window at 100 feet HAT may be considered to be equivalent to that specified for a value of RNP.01, and its related containment (e.g., A 470 feet lateral window at 100 feet HAT equivalent to RNP.01). A 470 feet lateral window may be assumed, and may be related to RNP.01 as follows:

> [(RNP .01nm x 2= 120 feet containment limit)+(115 feet wing semi-span) = ±235 feet half-lateral approach window, or a 470 feet lateral approach window at 100 feet HAT]

2.3.2. VERTICAL PERFORMANCE.

2.3.2.1. A maximum of 19 feet wheel to G/S antenna/navigation reference point height, and a level terrain DA(H) of 81 feet RA may be assumed at the 100 feet HAT point.

2.3.2.2. A value of ±12 feet (2 sigma) vertical tracking performance based on an equivalent performance level to that specified previously in superseded AC 120-29 Change 3 may be used, and may be assumed to be met at 100' HAT (81 feet RA). This performance level is considered to provide for 4 sigma navigation reference point containment of ± 24 feet, or a vertical window of 48 feet at 100 feet HAT.

2.4. OTHER CONSIDERATIONS.

Use of RNP criteria does not affect and should not affect application of other applicable obstacle assessment processes related to obstacle construction (e.g., Obstacle Identification analysis or aeronautical studies assessing obstructions in navigable airspace per FAR Part 77). This criteria is not intended to replace criteria established by FAA for airspace planning (e.g., Air Traffic planning for simultaneous instrument approach operations).

APPENDIX 6.

GROUND SYSTEM AND OBSTRUCTION CLEARANCE CRITERIA FOR CATEGORY II APPROACH AND LANDING OPERATIONS

1. PURPOSE. This Appendix outlines ground system and obstruction clearance criteria for Category II approach and landing operations supported by ILS, MLS, or GLS (e.g., GPS/DGPS LAAS), or for Category II operations based on RNP. To the extent that this criteria relates to or is referenced by criteria in AC120-28D, as amended, for Category III, it may also be used as the basis for Category III criteria.

2. GENERAL. Category II procedures are based on both navigation and visual guidance systems. The navigation system must be capable of guiding an aircraft to the runway reference datum (e.g., the ILS, MLS, GLS or RNP based glide path reference datum) with appropriate accuracy. The visual guidance system must provide appropriate visual cues to the pilot on approach from at least the decision altitude (height), down to and including touchdown, and along the runway for rollout, under the appropriate visibility conditions.

In order for a runway to qualify for Category II operations, the runway must be capable of supporting the lowest Category I minimums.

Runways which do not meet the criteria established in this appendix, but where an operational or other evaluation identifies that an equivalent level of safety exists, may be authorized appropriate Category II minimums. Such an evaluation shall be conducted by Flight Standards Service on a case-by case basis as required.

This circular, Standard Operations-Specifications, as amended, and the criteria in the Air Transportation Operations Inspectors Handbook, FAA Order 8400.10, establish the lowest approach and landing minimums which can be authorized for Category II operations for air carriers operating under Title 14 of the Code of Federal Regulations (14 CFR) part 121 or part 135. These minima may also apply to commercial operators operating under 14 CFR part 125. The implementation guidelines in Order 8260.36A may be used for new ILS, GLS or MLS. Criteria in TERPS or ICAO PANS-Ops may be used for established ILS Procedures and facilities.

Foreign airports served by United States air carriers or commercial operators under part 121, 125, or 135 may be approved in accordance with the provisions of pertinent ICAO Annexes or Standards or Recommended Practices (SARPS), on a basis of a comparable level of safety.

3. SUPPORTING NAVIGATION AIDS OR SENSORS FOR CATEGORY II PROCEDURES.

a. NAVAID System(s). A system which meets appropriate integrity, continuity and reliability performance standards for a US Category II Procedure and provides continuous electronic guidance at least to the ILS reference datum (or equivalent for RNP) should be provided,consistent with the elements described below:

(1) Localizer or Localizer Equivalent Sensor Capability. The localizer or equivalent (e.g., LAAS/DGPS), or RNP equivalent lateral guidance should be provided from the specified coverage limit down to the specified reference datum, or equivalent, as indicated in the U.S. Flight Inspection Manual, FAA Handbook, 8200.1, as amended.

(2) Glide Slope or Glide slope Equivalent. The glide slope or elevation antenna, or glode slope equivalent (e.g., LAAS/DGPS), or RNP equivalent, should provide guidance in the vertical plane from the specified coverage limit down to the ILS reference datum, or equivalent, as indicated in the U.S. Flight Inspection Manual.

(3) VHF Marker Beacons. In addition to the outer and middle marker beacons for ILS, a 75 MHz inner marker beacon should be provided at each runway intended for a Public Use Published 14 CFR part 97 Category II Procedure based on ILS. Special procedures authorized through Operations-Specifications need not have one or more of the standard installed marker beacons if another suitable means to determine longitudinal position and suitable glideslope is available to the operator. Marker beacons may be provided, or equivalent waypoints or fixes or methods may be provided for Category II Procedures based on GLS or MLS.

b. Visual Guidance and Lighting Systems. The lighting system should provide suitable visual guidance from at least the point where an approaching aircraft is at the lowest applicable DA(H), through the remainder of the approach, flare, landing, and rollout. The system should consist of at least the following components or capabilities:

(1) Approach Lighting System. Lighting standards are as outlined in FAA Order 1010.39, as amended, except that a negative approach light plane gradient is not permitted in the inner 1500 ft. zone prior to threshold (unless otherwise approved by AFS-1). Where required, approved flush approach lighting system may be installed, (i.e., for a displaced landing threshold). For Special Category II Procedures authorized through Operations-Specifications, approach lighting at least equivalent to a MALSR should be installed, unless a different approach lighting configuration is approved by FAA for use by each applicable operator.

(2) Touchdown Zone Lighting System. A lighting system should be provided defining the runway touchdown zone and conforming to AC 150/5340-4C, as amended. For Special Category II Procedures authorized through Operations-Specifications, TDZ lighting need not necessarily be installed if the runway's lighting configuration is reviewed and approved by FAA for use by each applicable operator (e.g., based on use of autoland or HUD guidance systems).

(3) Centerline Lighting System. A centerline lighting system defining the runway centerline and conforming to AC 150/5340-4C, as amended, using L-843 and L-850 runway centerline lighting systems (orequivalent) should be provided. For Special Category II Procedures authorized through Operations-Specifications, centerline lighting need not necessarily be installed if the runway's lighting configuration is reviewed and approved by FAA for use by each applicable operator (e.g., based on use of autoland or HUD guidance systems).

(4) High Intensity Runway Edge Lighting. A high intensity runway edge lighting system (or equivalent) should be provided defining the lateral and longitudinal limits of the runway and conforming to AC 150-5340-24, as amended.

(5) Taxiway Turnoff Lighting Systems. Unless otherwise approved for Special Category II Procedures authorized through Operations-Specifications, taxiway turnoff lighting systems, stop bar, runway guard lighting, and critical area taxiway lighting designations should be provided in accordance with AC 120-57, as amended, and the AC 150/5340 series, as amended.

(6) All-Weather Runway Markings. Runways should be marked with all-weather runway markings as specified in AC 150/5340-1G, as amended.

c. Meteorological Reporting and Other Requirements. Unless otherwise authorized for Special Category II Procedures, the following additional meteorological reporting systems or other capabilities should be provided in conjunction with Category II procedures.

(1) Runway Visual Range (RVR). An RVR system should be provided to support Category II Instrument procedures. For U.S. operators, RVR is considered to be an instrumentally derived measurement system reporting minimum visibility in units of feet or meters, located adjacent to the applicable runway (see Appendix 1).

(a) For Category II Procedures on runways greater than 8000 feet in length, RVR for at least Touchdown Zone, Mid, and Rollout should be available. For Category II Procedures on runways less than or equal to 8000 feet in length, RVR for at least Touchdown Zone and Rollout should be available.

(b) For runways with more than 3 RVR reporting facilities (e.g., certain European locations) FAA may determine which and how many transmissometers may apply to US Operators operations, unless specifically addressed by the state of the Aerodrome.

(c) If approved by AFS-1, Category II Procedures may be approved on a case by case basis using only TDZ RVR, or adjacent or nearby runway RVR reports. Where transmissometers from other runways are used, they should typically be located within a radius of 2000 ft. of the applicable portion of the runway being served, and provide a minimum of 1000 ft. coverage volume of the pertinent area along the intended runway.

(d) Timely reports for TDZ, mid, and rollout RVR values should be provided to the air traffic system (e.g., Tower, TACON, ARTCC, as applicable) for transmission to pilots of arriving aircraft, and for transmission to meteorological services, for timely distribution to pilots and operators for pre-flight and enroute flight planning.

(e) Existing RVR systems with minimum RVR value reporting capability of 600 RVR may continue to be used until replaced or upgraded.

(f) New or replacement RVR systems should have capability to report RVR ranging from a minimum value of 300 feet, to a maximum value of at least 6000 feet. Readout increments should be in at least 100 foot increments up to at least 1000 RVR, and thereafter increments of 200 feet to 3000 RVR. Where possible, RVR systems with a useful reporting range of 50 feet RVR to 6500 feet RVR are desirable. Preferred reporting increments are 50 feet to 1000 RVR, 200 feet to 3000 RVR, and 500 feet beyond 3000 RVR. New or replacement systems should, if possible, be capable of reporting in units of feet or meters, so that if metric reports are introduced into the National Aviation System (NAS) or International Aviation System (INAS), RVR systems are easily capable of converting to use the alternate metric units.

(g) FAA Standard 008, as amended, prescribes installation criteria for RVR equipment, and AC 97-1, as amended, describes RVR measuring equipment and it use.

(2) Radar (Radio) Altimeter Height. Radar (radio) altimeter heights will be provided on the FAA Form 8260.3, (or equivalent operator reference material for Special Category II Procedures) indicating the vertical distance at the 100/150 foot DA(H), assuming a 19 feet wheel to navigation reference point height (e.g., glide slope antenna height) and the terrain on runway extended centerline beneath this aircraft reference point.

(3) Facility Status Remote Monitoring. Remote facility status monitoring should be provided for the following NAVAIDs or visual aids (see FAA Order 6750.24, as amended). For Special Category II Procedures authorized through Operations-Specifications, remote monitoring capability is desired, but is not required. If not provided, a method to assure timely reporting of failures reported to ATS or the airport to flight crews should be established.

(a) NAVAIDs.

(b) Approach lighting system.

(c) Relevant electrical power sources or systems

(d) Runway edge, centerline and touchdown zone lights.

(e) Critical taxiway lighting, runway guard lights, and stopbars.

(4) Facility Status Monitoring by Periodic Inspection or After Reported Failures. The following systems may require inspection by airport management or FAA personnel or pilot reports to determine if they are operating in accordance with specified criteria, reference AC 120-57, as amended. Monitoring procedures should be capable of detecting when more than 10 percent of the lights are inoperative. The lighting system/configuration should be considered inoperative when more than 10 percent of the lights are not functioning. Taxiway lights and individual airport/runway lights do not have to be remotely monitored. However, when visual aid lighting systems which support Category II are monitored by observation, the inspection interval should ensure that undetected failures of more than 10 percent of the lights, or more than two adjacent lights would be unlikely, taking into consideration lamp expected life, environmental conditions, etc. The procedure to visually verify operation of runway edge, centerline, and touchdown zone lights should specify that a visual inspection take place within one day prior to commencement of anticipated Category II operations, or at least daily for continued Category II operations. The following systems should be considered:

(a) Touchdown zone and centerline lights.

(b) Runway edge lights.

(c) Runway markings.

(d) Runway guard lights.

(e) Taxiway centerline lights.

(f) Taxiway clearance bar lights.

(g) Taxiway signs.

(h) Taxiway markings.

For Special Category II Procedures authorized through Operations-Specifications, NAVAID, lighting, and marking monitoring may be authorized foreach operator if a procedure is equivalent to the above provisions. and is approved by FAA considering use by each applicable operator.

d. Critical Areas. Obstacle critical areas will be marked and lighted to insure that ground traffic does not violate critical areas during specified operations. These areas may differ depending on the type of NAVAIDs used. Procedural methods may be used for Special Category II procedures, if assurance can be provided that critical areas can be suitably protected for each operator using the special procedure.

(1) Glide Path Critical Area. The glide path critical area for ILS installations is specified in FAA Order 6750.16B, as amended. The glide path critical area of the elevation antenna for MLS installations is specified in FAA Order 6830.5, as amended.

(2) Localizer Critical Area. The localizer critical area for ILS installations is specified in FAA Order 6750.16B, as amended. The Azimuth Antenna critical area for MLS installations is specified in FAA Order 6830.5, as amended.

4. OBSTACLE CLEARANCE CRITERIA. Unless otherwise specified by AFS-1 the criteria found in Handbook 8260.3B and FAA Order 8260.36 or this AC should be used to establish Category II minimums for each new ILS, MLS, or GLS based procedure. Handbook 8260.3B TERPS criteria may be used for previously established ILS systems. Appendix 5 of this AC contains guidance for RNP final approach and missed approach segments.